CITY OF AUSTIN
Austin Water

PROJECT MANUAL
Contract Documents and Technical Specifications

VOL. 4 of 6
Division 11 - 17

CONFORMED

Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

CITY OF AUSTIN
Public Works Department
505 Barton Springs Rd. Ste. 800
Austin, TX 78704

November 2022

CONFORMED DOCUMENTS
These Conformed Documents unify addenda issued during the bid period. If discrepancies between the Conformed Documents and the Bid Documents are found, the Bid Documents with the original addenda shall govern. Original sealed by Danny M. Hurtado, July 22, 2022, State of Texas PE No. 104266.

carollo®
TBPELS No. F-882

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Danny M. Hurtado,
June 17, 2022,
TX PE No. 104266.

CIVIL/MECHANICAL

SECTION NUMBERS:

DIVISION 00	11366B	15117
DIVISION 01	11375	15118
SERIES 100	11377A	15119
SERIES 200	11378A	15120
SERIES 300	11395A	15121
SERIES 500	11635	15244
SERIES 600	13120	15259
SERIES 700	13446	15278
802S	13447	15286
SP130S	14650	15293
06608	15050	15956
08332	15052	15958
09960	15061	17101
11289	15075	17302
11294C	15076	17305
11305	15110	17404
11312D	15111	17502
11312J	15112	17506
11312X	15115	17522
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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Kwasi Duose,
June 17, 2022,
TX PE No. 100650.

STRUCTURAL

SECTION NUMBERS:

SERIES 400	03055
SP401S	03072
SP403S	03600
SP405S	04055
SP406S	05140
SP408S	05190
SP410S	05310
SP411S	05500
SP416S	13122
SP510	
SP511	
SP720S	
SP721S	

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Chad Green,
February 28, 2022,
TX PE No. 119980.

HVAC

SECTION NUMBERS:

10910	15812
15082	15814
15084	15815
15282	15820
15294	15830
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Wild Horse Ranch Wastewater Treatment Plant Expansion
C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Jonathan P. Herrboldt,
February 28, 2022,
TX PE No. 135057.

MECHANICAL

SECTION NUMBERS:

11312R
11355A
11376A

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Casey G. Wauters,
February 28, 2022,
TX PE No. 93889.

CIVIL/MECHANICAL

RESPONSIBLE SPECIFICATION SECTIONS:

03160	11313	11333
09800	11323	11353
11312C	11324	14555
11312F	11327	

AECOM Technical Services, Inc.
13640 Briarwick Drive, Suite 200
Austin, Texas, 78729
TBPE REG. No. F-3580

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Stephanie D. Blew,
February 28, 2022,
TX PE No. 92682.

CIVIL

RESPONSIBLE SPECIFICATION SECTIONS:

15114 CHECK VALES (DUCK BILL)
SP436S P.C. CONCRETE VALLEY GUTTERS

CAS CONSULTING AND SERVICES, INC.
Civil Engineering | Program Management | Construction Management
TBPE REG. NO. F-003572
7908 CAMERON ROAD, AUSTIN, TX 78754; (512) 836-2388

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by K.A. Harutunian, February 28, 2022, TX PE No. 59181.	Original sealed by Anne H. Harutunian, February 28, 2022, TX PE No. 11571.	Original sealed by Shant Harutunian, February 28, 2022, TX PE No. 87735.

ELECTRICAL, INSTRUMENTATION AND CONTROL

RESPONSIBLE SPECIFICATION SECTIONS:

13390	16450
13851	16483
16120	16500
16121	16524
16130	16540
16140	16550
16150	16600
16200	16800
16205	17100
16222	17200
16264	17380
16300	17600
16350	SP16150
16444	SP16200

HARUTUNIAN ENGINEERING INCORPORATED (HEI)
Engineering and Environmental Consultants
8100 Cross Park Drive
Austin, Texas 78754
(512) 454-2788 FAX (512) 454-6434
TBPE Firm Registration No. F-2408

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CITY OF AUSTIN
Austin Water
Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
Linda L. Barlow,
February 24, 2022,
TX PE No. 63878.

TRAFFIC CONTROL PLAN DESIGN

RESPONSIBLE SPECIFICATION SECTIONS:

803S BARRICADES, SIGNS AND TRAFFIC HANDLING

HVJ ASSOCIATES
TBPELS # f-646
1701 DIRECTORS BLVD, SUITE 900
AUSTIN, TEXAS 78744

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Wild Horse Ranch Wastewater Treatment Plant Expansion

C.I.P. PROJECT NUMBER: 7265.004 / IFB NUMBER: 6100 CLMC924

Original sealed by
David Negrete,
February 28, 2022,
TX PE No. 11640.

Architect

RESPONSIBLE SPECIFICATION SECTIONS:

02360	07212	08210	09902
02870	07213	08330	10100
03350	07214	08410	10400
03550	07301	08710	10500
04220	07415	08800	10520
06100	07468	09260	10615
06410	07600	09310	10810
07110	07714	09511	11400
07160	07900	09650	12486
07210	08110	09670	12494

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ARCHITECTS, LLP

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SECTION 11289

ULTRAVIOLET DISINFECTION SYSTEM

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Specification for the equipment associated with the Ultraviolet (UV) Disinfection System. Furnish all labor, materials, equipment, and appurtenances required to provide an open-channel, gravity-flow, low-pressure, high-output (LPHO) lamps, UV disinfection system complete with automatic cleaning system. The UV system is to be complete and operational with all control and appurtenant equipment as shown on the Drawings and specified herein. UV Disinfection System Supplier (hereafter called Supplier) shall provide installation assistance, start-up, testing and operator-maintenance training for the UV system as described in this Section. The Supplier shall assist with commissioning and performance testing for the UV system as described in this Section.

A. Provide a complete UV Disinfection System that meets all the water quality requirements and all the UV reactor testing and design requirements as set forth by the Texas Commission on Environmental Quality (TCEQ) and the specifications in this section. In the event of a conflict between regulations and this section, the UV System Supplier shall meet the more restrictive standard.

B. Third-Party Reactor Validation Testing and the related Engineering Report for the UV reactor to be installed must be completed at the time of Proposal.

C. The minimum UV equipment requirement is specified in Attachment 1 (at the end of this Section).

D. Only Suppliers' UV system listed in Attachment 1 shall be accepted.

1.02 REFERENCES

A. National Water Research Institute (NWRI), Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse, Third Edition, 2012.

B. United States Environmental Protection Agency (EPA), Ultraviolet Disinfection Guidance Manual (UVDGM). 2006.

C. Uniform Protocol for Wastewater UV Validation Applications, International Ultraviolet Association (IUVA) News, 13 (2), 26–33. 2011.

B. Texas Commission on Environmental Quality, Chapter 217 - Design Criteria for Domestic Wastewater Systems, Subchapter L: Ultraviolet Light Disinfection, December 4, 2015.

C. Institute of Electrical and Electronics Engineers (IEEE), Standard 519 - IEEE Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems, 2014.

D. National Electrical Manufacturers Association (NEMA), NEMA 250 - Enclosures for Electrical Equipment (1,000 V Maximum), 2014.

E. Underwriters Laboratories, Inc. (UL), UL 508A - Standard for Industrial Control Panels, 2013.

1.03 DEFINITIONS

A. General: The terms listed below are used in this specification and shall have the following definitions:

1. UV Bank: One or more UV modules that the entire reactor train flow must pass through. Each bank consists of:
    a. High purity, quartz sleeves (one sleeve per lamp) to protect lamps from direct contact with the wastewater.
    b. Each UV Bank shall be connected to its ballasts by means of a multi-conductor cable fitted with a waterproof plug.
    c. UV intensity sensors to provide continuous monitoring of the reactor performance.
    d. Automatic on-line cleaning system for periodic cleaning of the quartz sleeves.
    e. Interconnection of electrical and control cabling between the UV lamps, sensors, cleaning mechanism, and the reactor ballast enclosures.
2. UV Channel (synonymous with UV Train): The independent combination of the UV banks, and inlet and outlet level controlling arrangements located in a concrete channel.
3. UV Disinfection Equipment System (synonymous with UV Disinfection System): The combination of all UV channels with associated controls and instrumentation.
4. UV Intensity Control: The use of calibrated UV sensors, meeting the recommendations of the United States Environmental Protection Agency's (USEPA) Ultraviolet Disinfection Guidance Manual (UVDGM) (2006), to continuously monitor UV intensity within the reactor. The measured UV intensity is used to indicate relative lamp output due to effluent quality, lamp aging, fouling, and ballast power settings, and is used as an input for UV dose-pacing algorithm programmed into the UV system's PLC. For some UV systems, the sensor reading is not utilized for dose pacing, the use of the sensors to monitor and alarm the combined effect of lamp aging and sleeve fouling can be sufficient.
5. Attenuated Lamp Conditions: Conditions where the lamps are at the end of their guaranteed lives and the quartz sleeves are fouled (i.e., consistent with the Lamp Age Factor and Sleeve Fouling Factor).
6. Lamp Age Factor: Reduction in available UV output at the end of the UV lamp life, as compared to a new UV lamp after 100 hours burn-in.
7. Lamp Life: Total guaranteed operational time that the UV lamp can deliver a UV output that is greater than or equal to the Lamp Age Factor.
8. Normalized Lamp Velocity: Flow velocity across a lamp (in gpm per lamp), calculated by the total expected flow in a UV channel (in gpm) divided by the total number of lamps in only one (1) bank in the channel.
9. Sleeve Fouling Factor: The sleeve fouling factor is a measure of the sleeve's loss of irradiance over time (expressed as a percentage of the irradiance from a new and clean quartz sleeve). Periodic automatic and manual cleaning of the system is performed to achieve a factor greater than the Sleeve Fouling Factor.
10. UV Intensity (UVI): The power per unit area passing through an area perpendicular to the direction of propagation. UV intensity is used to describe the magnitude of UV light in a UV reactor or in a bench-scale UV test.

11. UV Transmittance (UVT): A measure of the fraction of incident light transmitted through the water column. The UVT is the ratio of the light entering the effluent to that exiting the effluent. UVT is represented as a percentage. UVT is typically quantified by spectrophotometric measurement at a wavelength of 253.7 nm using a one-centimeter path length.
12. UV Module: The basic building block of a UV disinfection system. It is comprised of more than one UV lamp with a common electrical feed and/or cleaning system.
13. UV Dose:
    a. Reduction Equivalent Dose (RED): The dose that is assigned to the UV reactor under a given set of operating conditions that is based on Third-Party Reactor Validation Testing. The RED is equivalent to that measured with the collimated-beam apparatus for the same degree of inactivation of the test microorganism. RED is typically reported in millijoules per square centimeter (mJ/cm^2).
    a. Design RED: The RED delivered for a specific log inactivation of the test microorganism at the peak design flow at the design UVT and attenuated lamp conditions. The design RED is used to size the UV Disinfection System.
14. UV Reactor: An independent combination of single or multiple UV bank(s) in series with a common mode of failure (e.g., electrical, cooling, cleaning system, etc.).
15. UV Testing, Reports and References:
    a. Bioassay: A microbiological procedure used to determine the inactivation of a specific microorganism after exposure to UV light through a specific UV reactor.
    a. Engineering Report: A bioassay testing report prepared and stamped by an independent, third party licensed civil engineer, registered in the United States. The Report is in accordance with Third Party Reactor Validation Testing. The Report summarizes the results of the third party bioassay testing, and documents the dose equation used to size and operate the proposed UV Disinfection System.
    b. Hydraulic, Alarm and Functional Testing: As specified herein and per Third Party Reactor Validation Testing Guidelines, testing shall be completed to verify that alarm, control functions, headloss, and hydraulics specifications are met. To ensure this, tests shall be run at minimum, average, and peak flow over the range of channel operating conditions specified herein.
    c. Initial Performance Test: A 5-day continuous test to demonstrate the installed UV Disinfection System meets the performance test requirements specified herein and produces an effluent in complete compliance with requirements as specified herein.
    d. Third-Party Reactor Validation Testing: Testing completed on a pilot scale or full scale UV system in accordance with a test protocol per Third-Party Reactor Validation Testing, in compliance with the NWRI UV Guidelines (2012). Testing is conducted to develop reactor dose delivery for various operational conditions. A third-party licensed civil engineer in the United States must perform the testing.
16. Project Manager: Supplier's personnel having a minimum of 5 years of experience in design and execution of wastewater UV systems to utilities.

1.04 PROJECT MANAGEMENT AND QUALITY ASSURANCE

A. The Supplier shall assign a qualified and experienced project manager for the duration of the project from initial selection through start-up. This project manager shall remain the same throughout the duration of the project. Any changes in project management will require approval from the Owner and Engineer after they review the qualifications of the proposed candidates:
   1. The project manager shall act as the main point of communication between Owner, Engineer, Contractor, and Supplier regarding the administration of the procurement contract, payment requests, interpretations of contract terms and conditions, warranty, technical aspects of the UV Disinfection Equipment System, including design criteria, materials selection, equipment, control systems, and coordination between Supplier and other parties during the design, bidding, shop drawing submission and reviews, RFIs, and scheduling deliveries, field inspections, start-up, and performance testing during construction.

1.05 SYSTEM DESCRIPTION

A. Provide a UV disinfection system complete with UV Banks, a control system, UV intensity sensors, automatic on-line cleaning system, UV transmittance analyzer, power distribution system, level control weir, and accessories as specified herein or as required in order to have a complete and functioning system.

B. The UV Disinfection System shall be able to continuously provide disinfection at the Average Daily Flow rate, at the design UVT, and with attenuated lamp conditions, under the following circumstances:
   1. While one bank is out of service and all remaining banks are in service.
   2. While the automatic on-line cleaning system is in operation.
   3. While the UV lamps, quartz sleeves, and/or ballasts are being replaced in the out of service bank.

C. The UV Disinfection System shall be able to continuously provide disinfection at the Peak 2-Hour Flow rate, at the design UVT, and with attenuated lamp conditions, with all equipment in operation. UV Supplier must guarantee headloss for the peak flow conditions.

D. Design Criteria:
   1. Supplier shall provide UV disinfection equipment which meets the Performance Requirements, specified in this Section, based on the following conditions:
      a. Influent Water Quality:
         1) Description: Tertiary effluent.
         2) Peak 2-Hour Flow: 9.0 million gallons per day (mgd).
         3) Average Daily Flow: 2.25 mgd.
         4) Design Ultraviolet Transmittance (UVT) at 253.7 nm: 65 percent.
         5) Average UV Transmittance at 253.7 nm: 69 percent.
         6) Total Suspended Solids, 7-Day Average: < 10 mg/L.
      b. The UV Disinfection System shall meet the design criteria as specified herein and in Attachment 1:
         1) This minimum dose must be based upon the delivered MS2 RED equation developed based on the Supplier's NWRI 2012 validation

testing results. The Engineer can apply the required correction factor to the Supplier's bioassay results based upon the Engineer's analysis of the Validation Testing and site conditions.

2) Hydraulic Constraints:
   a) Supplier shall specify the maximum water surface elevation at which the UV system can operate (based on Third Party Reactor Validation Testing).
   b) Supplier shall specify the minimum water surface elevation that must be maintained at all times, in any channel that contains UV lamps that are turned "ON."
   c) Maximum Acceptable Normalized Lamp Velocity (gpm/lamp): To be specified by Supplier and shall not exceed maximum value proven effective during Third Party Validation Testing or IUVA Uniform Protocol Validation Testing.
   d) Minimum Acceptable Normalized Lamp Velocity: To be specified by Supplier and shall not be lower than the minimum value proven effective during Third Party Validation Testing.
3) Minimum Lamp Life: As stated in Attachment 1.
4) Lamp Age Factor: As stated in Attachment 1, Maximum Value - 0.86.
5) Sleeve Fouling Factor: As stated in Attachment 1, Maximum Value - 0.94.
6) The UV sensors employed by Supplier must track the combined intensity loss due to lamp aging and sleeve fouling (attenuated lamp condition).
7) Number of channels: Channel requirement is specified in Attachment 1.
8) Banks per channel: Banks requirement is specified in Attachment 1.

E. Performance Requirements:
1. The UV disinfection system performance shall be guaranteed by the Supplier to produce an effluent that meets or exceeds the following:
   a. *E. coli* count of less than 120 CFU or MPN per 100 mL, based on a 30-day geometric mean.
      1) Grab samples shall be taken in accordance with the Microbiology Sampling Techniques found in Standard Methods for the Examination of Water and Wastewater, Latest Edition.
2. Minimum UV Dose:
   a. The system shall produce a MS2 RED equal to or greater than the minimum MS2 Design RED of 23.5 mJ/cm^2 specified herein at peak flow, the design UVT and under attenuated lamp conditions. The basis for evaluating the dose delivered by the UV disinfection system shall be the Supplier's bioassay results as determined by Third-Party Reactor Validation Testing per the NWRI UV Guidelines (2012) with the Confidence Ratio (CR) set to 1.00. The Engineer can apply the required correction factor to the Supplier's bioassay results.
3. The power factor shall be 98 percent or greater. Harmonic distortion shall be measured with all UV banks at 100 percent rated load in accordance with a general system classification meeting the recommended maximum harmonic distortion levels in IEEE 519-2014 Tables 1, and 2 at the Point of Common Coupling (PCC). The PCC is defined as the line side of one Power Distribution Center (PDC). The short-circuit current (I_{SC}) to load current (I_L) ratio for the plant at the PCC is greater than 20 at 480 volts.

F. The requirements stated in Attachment 1 are minimum requirements. If the UV Supplier determines more equipment is needed then the UV Supplier must provide the additional equipment to meet the performance requirement.

G. The UV channels shall be located outdoors under a canopy. The electrical enclosures with the electronic ballasts and the master PLC shall be located indoors in an electrical building and shall be designed accordingly.

H. Facility Constraints: All components of the UV system must fit within the footprint as shown in the Drawings, including proper approach and exit lengths, electrical equipment, and reasonable operations and maintenance access.

1.06 SUBMITTALS

A. Product Data and Shop Drawings: Equipment Supplier shall submit, per Section 01300 - Submittals, the following:
   1. Product data, including, but not limited to, the following:
      a. Complete description in sufficient detail to permit an item-by-item comparison with the Specifications.
      b. Descriptive information including catalog cuts and Supplier's specifications for all components.
      c. Written field electrical termination requirements and instructions as required for the Contractor to install a complete and operational system.
      d. Third Party Reactor Validation Testing results and corresponding Engineering Report(s).
      e. Number of lamps per module.
      f. Number of modules per bank.
      g. Total number of UV lamps.
   2. General Shop drawing submittal including, but not limited to:
      a. Details of the UV Module/Bank, ballast enclosure, power distribution system with transformers as required, and control system.
      b. Dimensions and installation requirements.
      c. Information on the channel configuration, including but not limited to: widths, depths, lengths, and any other items necessary to confirm the proposed system will fit into the proposed UV channels.
   3. Electrical, Instrumentation and Controls data and shop drawings specified in all Division 16 and 17 Specifications as well as Section 13390 – Packaged Control Systems, including but not limited to:
      a. Front exterior and interior panel layout drawings with bill of materials for all electrical and control panels.
      b. Control schematics with wire numbers.
      c. Detailed interface and interconnection drawings that indicate all UV system and external component and equipment connections.
      d. Detailed electrical wiring diagrams as required for the Contractor to install a complete operational system including, but not be limited to:
         1) Source power feeder conductor quantities and sizes.
         2) Control wiring quantities and sizes.
         3) Signal cable quantities and sizes.
         4) Power (kW), power factor and apparent power (kVA) for each UV Bank and/or Power Distribution Center.
         5) Master UV PLC power requirements.
         6) Cut sheets for each electrical power and control device.

e. Control philosophy narrative with integration of the Third-Party Reactor Validation Testing results, including the use of the sensors to monitor and alarm the combined effect of lamp aging and sleeve fouling and/or the use of the sensors to continuously monitor UV dose based on inputs of flow, UV sensor intensity, and UV transmittance (UVT).
f. Provide a wiring diagram complete with all inter-equipment wiring and conduit requirements.
g. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.
h. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium voltage power cables.
i. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
j. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
    1) The manufacturer's model number or other identifying product designation.
    2) Tag and loop number.
    3) System to which it belongs.
    4) Site to which it applies.
    5) Input and output characteristics.
    6) Requirements for electric power.
    7) Device ambient operating requirements.
    8) Materials of construction.
k. Electronic copy on a USB flash drive of the UV PLC system program.
l. Electronic copy on a USB flash drive of the Operator Interface Unit (OIU) program.

4. List of spare parts to be provided by Supplier.
5. UV Master Control Panel (MCP):
    a. Proposed layout of mounted devices and terminals with dimensions within MCP.
    b. Proposed MCP PLC programming printout with input/output (I/O) listing if available.
    c. Complete I/O list:
        1) A table showing all the data available over EtherNet/IP communication protocol to the plant control system.
    d. Proposed MCP OIU graphic display printouts.
    e. Operating description for MCP: Include detailed descriptions of all logic and sequences of operation of control loops within the MCP controller, points monitored, available local and automatic control functions, and alarms. Include a description of the controls interface and communication between the MCP and Plant PLC. Provide a more detailed description of these functions than is described in these Specifications.
6. PLC cabinet:
    a. Panel exterior and internal elevations with detailed bill of materials.
    b. PLC power schematic and I/O shop drawings.
    c. Product data for panel and all components.
    d. PLC memory and spare I/O calculations.
    e. UPS calculations.
    f. Thermal management calculations.

B. Operation and Maintenance Manuals:
   1. UV equipment Supplier shall submit operation and maintenance manuals in accordance with Section 01730 - Operation and Maintenance Manuals.
      a. In addition to the requirements listed in the above referenced section, the Operation and Maintenance Manuals shall include:
         1) Name, address, and telephone number of nearest Supplier and spare parts warehouse.
         2) Special tools required for operation and maintenance.
         3) Reproducible prints of the Contract diagrams, schematics, and installation drawings for electrical and instrumentation work.
   2. The Engineer will not approve an equipment unit before its manual has been accepted.
   3. UV equipment Supplier's copy of complete manuals shall be available at the site of the work for use by field personnel and Engineer during Hydraulic, Alarm and Functional Testing, and Performance Testing of equipment.
   4. Step by step instructions for operation and maintenance of all equipment provided by Supplier.
   5. Description of process control logic and process and instrumentation diagrams.
   6. Drawings of all control panels to include:
      a. Electrical ladder diagram.
      b. Interconnect to all components outside the panel.
      c. Door layout.
      d. Interior layout.
      e. Sample Operator Interface screens for the local panels and Master Control Panel.
   7. Operating description for the MCPs. Provide a copy of the software ladder logic covering all logic and sequences of operation. Provide a soft copy of all documented PLC code on USB flash drive. Provide a list of instrument settings:
      a. In the event that a soft copy of the PLC code cannot be provided to the Owner, provide one (1) spare pre-programmed PLC or microprocessor/CPU.
   8. Provide a detailed description of the data collection and monitoring software. Provide typical Operator Interface screens with detailed descriptions, the various tattletale monitors, preventative maintenance items, and data logging features.
   9. Provide I/O listing for all control panel PLCs.
   10. Indicate all scheduled maintenance requirements and routine inspections. Include maintenance summary forms.
   11. Provide list of recommended spare parts and lubricants.
   12. Provide a troubleshooting guide.
   13. Provide the local sales representative contact information with the company name, contact person, phone number, and address.

C. Quality Certification:
   1. Supplier shall submit Engineering Report of the proposed UV Disinfection System, including:
      a. All raw data used to justify the conclusions of the Third-Party Reactor Validation Testing.

b. Test reactor configuration including tested parameters (e.g., flow rates, UV transmittance, number of reactors/lamps in operation, and type of water tested).
c. Collimated beam results.
d. Reactor validation results with regard to inactivation of the test organism.
e. Test results from headloss testing.
f. Recommended normalized lamp velocity range (flow/lamp) to meet the required Design UV Dose.
g. Delivered UV Dose equation developed based on Supplier's Third-Party Reactor Validation Testing.

2. Hydraulic calculations demonstrating compliance with the hydraulic constraints specified herein.
3. Representative harmonic analysis calculations and reports for both voltage and current at the point of common coupling, as defined as the input terminals to the power distribution center. Certification that voltage and current harmonic distortion levels are within IEEE 519 Standard limits at the point of common coupling when powered from utility power supply in accordance with Article 1.05.E.3.
4. Supplier's UV equipment warranty including lamps, ballasts, quartz sleeves, wipers, and UV sensors, as specified herein.
5. Supplier's performance warranty as specified herein.
6. Documentation of the successful completion and results of the Underwriter's Laboratory (UL) or equivalent testing shall be provided.
7. Initial Performance Test protocol to fulfill requirements outlined herein.

B. Closeout Submittals:
1. Written certification of proper UV system installation as outlined in Article 3.03.B herein.
2. One copy of all UV PLC, operator interface, and other programs required for the maintenance of the UV system in native format on USB flash drive:
a. PLC and OIU Programs:
1) Provide complete electronic copies of the PLC and OIU programs and configuration files for all equipment in the local control panels, in the native file format of each device, along with any supporting files. Programs shall be fully accessible for use by the Owner – programs that are locked, restricted, or contain hidden materials are not permitted.
b. Provide a detailed description of control systems.
c. Provide panel drawings, wiring diagrams, specifications, and a detailed description of the local panels.

C. Other Qualification Requirement Submittals:
1. A statement listing any deviations or exceptions taken to these specifications. Include specification reference and proposed alternative with reason stated for exception.

1.07 QUALITY ASSURANCE

A. Qualification Requirements:
   1. The UV equipment Supplier shall demonstrate that the dose required in the performance specification can be met with the amount of equipment proposed. The UV equipment Supplier shall base sizing of UV system on a Third-Party Reactor Validation Testing calculation to meet the minimum UV design dose as specified herein. The UV equipment Supplier's data and results shall be reviewed by the Engineer. The Engineer can apply the required correction factor to the Supplier's bioassay results. The Engineer's review and opinion of the test protocol, pilot data, and pilot report conclusions shall be deemed final and shall be just cause for the rejection of the proposed equipment. In addition, bioassay calculations shall use one method for the calculation of gpm per lamp for all data, as defined herein as the "Normalized Lamp Velocity."
   2. A statement by the UV equipment Supplier listing any deviations or exceptions taken to these specifications shall be provided to the Engineer for the Engineer's review, opinion, and acceptance. The Engineer's final decision regarding the acceptance or denial of any deviations or exceptions shall be just cause for the rejection of the proposed equipment and require that the equipment Supplier supply the disinfection equipment as specified herein.
   3. Provide equipment labeled and listed by Underwriters Laboratory (UL) or another nationally recognized testing laboratory, furnished by a single Supplier qualified and experienced in the production of similar equipment.

1.08 DELIVERY, STORAGE AND HANDLING

A. If required by the Contractor's schedule, the Supplier shall provide equipment in multiple separate freight shipments.

B. Provide notification in writing to the Owner and Contractor of approximate delivery date(s) 4 weeks before delivery. Notify same of actual delivery date at least 7 days before delivery. Provide description and approximate weight of shipping container and required equipment for unloading. Supplier shall coordinate delivery, unloading, and storage with Contractor.

C. Moisture sensitive products shall be stored in appropriate weather tight enclosures or locations. Supplier will designate those items that need to be stored in a moisture controlled environment. Crates covered in tarps are not acceptable. All damaged materials related to storage shall be replaced with new materials.

D. Supplier shall coordinate the delivery of equipment with Contractor. Supplier's shipping company shall notify the Contractor at least 48 hours prior to arrival on site. Supplier shall revise schedule for delivering equipment packages if requested by Contractor without additional cost to Contractor.

E. Storage:
   1. General: Contractor shall store, and handle in accordance with the Supplier's printed instructions.
   2. Packing and Shipping: Supplier shall deliver equipment to the project site in the original containers with seals unbroken and labeled with Supplier's identification and number.

3. Delivery: Supplier shall deliver materials dry and undamaged to the Contractor. During the delivery process materials must be stored out of contact with the ground.

1.09 SUPPLIER'S WARRANTY

A. The equipment Supplier shall warrant the Owner against defects in materials and workmanship in accordance with the INSTRUCTIONS TO PROPOSERS and the following:
   1. General Warranty:
      a. The equipment furnished under this Section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation, for a period of 1 year which shall commence from the date of Substantial Completion for the Project.
      b. All wiring in the channel exposed to UV light shall be warranted for 15 years by the Supplier. If the wiring fails before 15 years have elapsed, the Supplier shall be responsible for the replacement of the wires and the labor.
      c. Supplier shall guarantee that for components manufactured by the Supplier, replacement parts shall continue to be available to the Owner for a minimum of 20 years from date of successful completion of Initial Performance Test. Supplier shall guarantee that, if Supplier or Supplier's product line is sold, Supplier shall make provisions such that all guarantees, warrantees, and bonds will remain in effect and that replacement parts and operational support shall continue to be available to the Owner for the time period specified above.
      d. No warrantees shall be pro-rated, and all warrantees shall include all costs associated with required site visits, inspections, equipment removal costs, and equipment installation costs.
      e. All warrantees and support shall be provided directly by the Supplier and not the local manufacturer's representative.
   2. UV Lamp Warranty:
      a. The UV lamps shall be warranted by the Supplier against lamp failure as specified herein. Lamp failure occurs when the ratio of the available UV light output of the lamp to the UV light output of a new lamp after 100 hours of burn-in is less than the lamp age factor. The Supplier shall provide a warranty for the performance of the UV lamp for a minimum period of operating hours per lamp as stated in Attachment 1, which shall commence after successful completion of the Initial Performance Test (Substantial Completion).
      b. The Supplier shall replace any lamp that fails before the end of the operating hours per lamp as stated in Attachment 1 at no cost to the Owner, with freight and insurance paid by Supplier. Installation of the replacement lamp can be performed by the Owner.
      c. This guarantee shall be limited by the guaranteed number of start/stop cycles. The guaranteed lamp start/stop cycle shall be 4 stop/start cycles per 24-hour period over the life of the lamp. The automation associated with the UV equipment shall be programmed to prevent more than 4 start/stop cycles per day. Additionally, the automation system must log the operational hours for each individual lamp.
      d. The guaranteed lamp life shall not be limited by time periods when the plant is not in operation and/or when the UV system is shut down.

e. Supplier shall ensure all returned UV lamps (old/new) are recycled upon receipt of the returned lamps at the manufacturing headquarters for the life of the UV Disinfection System (20 years after successful completion of the Initial Performance Test). Only lamps purchased directly from the Supplier can be returned for recycling.

3. UV Ballast Warranty:
   a. Supplier shall guarantee all ballasts against failure for a minimum period of 5 years, which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system).
   b. Supplier shall replace any ballast that fails before the end of the designated warranty period at no cost to the Owner, with freight and insurance paid by Supplier. Installation of the replacement ballast can be performed by Owner.
4. UV Quartz Sleeves Warranty:
   a. Supplier shall guarantee all quartz sleeves against failure for a minimum period of 5 years, which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system). Sleeve failure is defined as permanent loss of 10 percent sleeve transmittance relative to new sleeve transmittance.
   b. Supplier shall replace any quartz sleeve that fails before the end of the designated warranty period at no cost to the Owner, with freight and insurance paid by Supplier. Installation of the replacement quartz sleeve can be performed by Owner.
5. UV Sensor Extended Warranty:
   a. Supplier shall guarantee all UV sensors against failure for a minimum period of 3 years, which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system). Sensor is deemed to have failed when the sensor no longer measures UV intensity or sensor does not meet the specified accuracy of less than 20 percent.
   b. Supplier shall replace any UV sensor that fails before the end of the warranty period at no cost to the Owner, with freight and insurance paid by Supplier. Installation of the replacement UV sensor can be performed by Owner.
6. Performance Warranty:
   a. The equipment furnished under this Section, when operated within the conditions specified in the Contract Documents, will meet or exceed the performance requirements specified herein for a period of 3 years which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system).
   b. If the UV equipment fails to meet design and performance criteria, the UV equipment Supplier shall modify, change, or add equipment as necessary to meet performance criteria. Supplier shall be responsible for any additional costs to Contractor or Owner due to changes (including but not limited to piping, mechanical, structural, or electrical changes) or additional equipment as necessary to meet performance requirements. This includes design, engineering, construction, as well as equipment.
   c. The Owner shall make available the UV Disinfection System electronic data records of historical performance for Supplier’s review. The automation system shall log all relevant performance data and store it in the historical database.

d. If the system fails to meet specified performance criteria during the Initial Performance Test, or the warranty period following the date of successful completion of the Initial Performance Test, and the Supplier is unable to modify the system through the addition of UV banks or other elements, then the Supplier shall be responsible for complete removal of non-conforming system and subsequent installation of UV disinfection products that are capable of meeting specified performance conditions.

B. The equipment Supplier shall warrant the Owner regarding power consumption as follows:
   1. The Supplier shall furnish a warranty stating that the installed UV system shall not exceed the maximum power consumption as specified in Attachment 1.
   2. If this maximum power usage is exceeded due to system modifications by Supplier or by design, the Supplier agrees to pay Owner the cost of upgrading any portion of the electrical system to accommodate the new maximum power consumption. This includes material, labor and engineering costs.

C. End of Warranty Inspection:
   1. Inspection:
      a. Supplier's representative shall perform a minimum of one-day (eight hour) inspection of Supplier's UV equipment, within 30 days prior to the 1-year anniversary date of the General equipment warranty.
      b. Supplier shall ascertain or appraise the following:
         1) Status of equipment and installation after normal usage.
         2) Adherence to Supplier's recommended maintenance and operation of equipment.
         3) Quality of sleeve cleaning and recommended sleeve cleaning interval.
         4) All electrical connections.
         5) Calibration of duty UV sensors using reference UV sensors.
         6) Operation of alarms.
         7) UV transmittance monitors.
      c. Supplier shall make adjustments as necessary to restore equipment within original tolerances.
      d. Supplier shall submit a written letter report to the Owner covering the inspection items and including recommendations where applicable.

1.10 MAINTENANCE

A. Special Tools: Provide 1 set of all special tools required for operation and maintenance, and complete assembly or disassembly of the UV disinfection system.

B. Spare Parts: The UV Disinfection System Supplier shall furnish, at a minimum, the following spare parts for each system provided:
   1. UV Lamps: Six (6).
   2. UV Ballasts (complete): Three (3).
   3. Quartz Sleeves: Six (6).
   4. Lamp Sealing Rings or Holder Seals: Six (6).
   5. Lamp Plug Assemblies: Six (6).
   6. Lamp Cables: Three (3).
   7. Wiper or Wiper Rings: One hundred (100) percent additional.
   8. UV Sensors: Two (2).

9. Proprietary Printed circuit boards: Five (5) percent additional of each type supplied with a minimum quantity of one (1).
10. Fans: Five (5) percent additional of each type supplied with a minimum quantity of one (1) of each type.
11. Cabinet Air Filters: One hundred (100) percent additional of each type supplied.
12. Pump or Electric Motor with Gearbox used to drive cleaning system and/or UV module lift system: One (1) of each type used, if required for System.
13. Fuses: Five (5) of each type of fuse used in the UV system.
14. Benchtop UV Transmittance Meter: One (1), manufactured by Real Tech Inc. (Model # UV254 P200).
15. Manufacturer shall warrant that, after substantial completion, any submodule needed for repair shall be capable of being shipped to the project site within five days of notification. Critical service spares, including motors, ballasts, OIUs, control cards, CPUs, etc. shall be available within 36 hours. Full replacement, should it be needed, shall be guaranteed onsite within 21 days.

1.11 WORK BY OTHERS

A. The following items are provided by the Contractor but shall be coordinated by the Supplier during the Design Assistance provided by Supplier to Engineer. These items will include:
   1. Structural:
      a. Concrete channels for the UV reactors.
      b. Foundation/housekeeping pads and additional housing for supplied UV disinfection equipment.
      c. Anchor bolts will be provided and installed by Contractor; anchor bolt design by UV Supplier.
   2. Mechanical:
      a. Level control weir used to control the effluent level in the channel shall be supplied by the Supplier and installed by Contractor. The UV Supplier shall review the weir design to ensure it complies with their system requirements.
      b. Installation materials for instrumentation and automatic valves including but not limited to air/sample line tubing, fittings, and mountings.
      c. Installation of all UV disinfection system components.
   3. Electrical:
      a. Electrical wiring interconnections (including wiring, conduit, cable trays, transformers, and other appurtenances required to provide power connections as needed) from the electrical power source to the UV disinfection equipment and system control panels. Contractor shall also be responsible for determining the correct wire sizing and coordinate this information with the UV Supplier.
      b. The lamp cables between the UV banks and Power Distribution Centers shall be supplied by the UV Supplier and will be run/pulled and terminated by the Contractor.
      a. Communication cabling between the Power Distribution Centers and Mater Control Panel shall be provided by the Contractor based on the UV Supplier's requirements.
      b. Ethernet communications connection to the Owner’s Plant Control System.

c. Installation of all electrical enclosures for a complete UV disinfection system.

4. Other:
   a. Receiving, unloading, and safe storage of equipment at site or a storage facility until ready for installation.
   b. Raw materials and utilities during equipment testing.
   c. Laboratory services, operating and maintenance personnel during equipment checkout, startup and operations.
   d. Any onsite painting or touch-up painting of equipment supplied.

PART 2 PRODUCTS

2.01 SUPPLIERS

A. The UV Disinfection System shall be manufactured by the following equipment manufacturers supplier:
   1. Wedeco, a Xylem brand, Duron™.
   2. Trojan UVSigna™ 2-Row.

B. Contract Drawings are based on the Wedeco Duron System. If Contractor wishes to furnish equipment by another manufacturer that meets all specification requirements, then all costs associated with modifications to adapt the facilities as designed to accommodate proposed equipment shall be borne by Contractor. This shall include all design, procurement, and installation costs for any necessary structural, mechanical, electrical, instrumentation and control, and any other changes required for a compete and satisfactory installation, including Engineer's cost for redesign.

2.02 GENERAL PRODUCT REQUIREMENTS

A. Description of Work:
   1. The work under this Section shall cover furnishing a complete and operational open-channel, gravity-flow, UV disinfection system. The system shall be complete with UV banks, power distribution, master control, UV detection system and automatic cleaning system as shown on the Drawings and specified herein.
   2. The system shall utilize active dose control based on the Third-Party Reactor Validation Testing and using the following parameters:
      a. UV intensity, as measured by a calibrated sensor technology meeting USEPA/UVDGM standards.
      b. Water quality (UVT).
      c. Water flow (channel flow provided by Plant SCADA).
      d. Power (Ballast Power Level or Percent Lamp Current).
      e. Based on these parameters, the system will automatically vary the UV lamp power proportionally to continuously meet the dose requirement.
   3. The dose delivered by the UV system shall be linearly variable within a minimum range of 50 to 100 percent of maximum power in both manual and automatic operating modes. If the variability differs between modes, the automatic mode of operation shall be the sole mode considered.
   4. The system shall be capable of continuous disinfection while automatically cleaning the UV lamp sleeves without reducing or shadowing the output of the

lamps. For systems that require batch chemical cleaning, system redundancy can be used during the batch cleaning process to maintain the required dose.

5. The UV sensor technology employed by the Supplier must continuously track the combined intensity loss due to lamp aging and sleeve fouling and alarm when the intensity level is greater than an adjustable percentage setpoint from the validated UV intensity for the same operating conditions.

B. General:
   1. Unless otherwise specified, all components in contact with the effluent and/or UV light shall be Type 316 stainless steel, Type 214 quartz glass, Viton or Teflon. All wiring exposed to UV light shall be Teflon-coated.
   2. All fasteners in contact with the effluent shall be Type 316 stainless steel.
   3. Unless otherwise specified, all metal components above the effluent shall be Type 316 stainless steel.
   4. All enclosures located outdoors shall be 316 Stainless Steel - NEMA 4X, unless specified otherwise. All enclosures located indoors shall be primed, power-coated steel - NEMA 12, unless specified otherwise.
   5. All stainless steel components and welds in stainless steel subassemblies shall be cleaned, pickled, and passivated to protect the stainless steel:
      a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
      c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated:
         1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
      d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A 380 to remove deposited contaminants before shipping:
         1) Passivation by citric acid treatment is not allowed.
         2) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
         3) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A 380.
         4) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A 380.
      e. After cleaning, inspect using methods specified for “gross inspection” in ASTM A 380.
      f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

~~B.~~C. Master Control Panel General Requirements: AD3
   1. Programming – The Supplier shall provide all control equipment and programming as required for a complete and functional UV control system that

performs all functions described herein and as indicated on the Project P&IDs, with the exception of programming required for the plant SCADA system:

a. The Supplier shall be responsible for preparing, writing, and testing all PLC programming logic associated with the UV control system, and shall provide a system block diagram complete with all inter-equipment wiring and conduit requirements.
b. Provide status, alarms, and process variable data to the plant SCADA system. Control signals shall also be accepted from the plant SCADA system. Coordinate all tagging and memory mapping with the Contractor and follow the Engineer's direction.
c. Programming for the UV control system shall include interface with the cloth media disc filters upstream of the UV system.
d. Programming for the plant SCADA system shall be done by others hereby designated as the Programmer.
e. Supplier shall coordinate with the Contractor and the Programmer while developing the software design.
f. Supplier shall include an allowance for an additional 16 hours (each) for the PLC and OIU to accommodate SCADA coordination programming. Execution of hours will be determined by Engineer and Owner as needed.

2. Master Control Panel:
   a. The UV system Supplier shall provide a PLC-based Control Panel to monitor and control all equipment associated with the UV Supplier's system. The UV MCP shall operate as an interface between the UV control system and the Plant PLC system. ~~The Master UV PLC shall communicate to the Plant PLC system through Ethernet communications using Modbus TCP protocol.~~ Network communication between the UV system and the Plant SCADA system shall be by means of Type 2 fiber optic cable as shown on the network architecture drawing on sheet 50N04. The UV PLC shall be provided and programmed by the UV system Supplier. Provide communication capability for monitoring and controlling the UV system through the plant SCADA system as specified in Division 17, the contract drawings, and this section. AD3
   b. MCP shall be provided in accordance with Section 13390 – Packaged Control Systems.
   c. MCP shall have a UPS with 1.5 safety factor and 30 minute runtime. The UPS shall be provided by the Supplier in accordance with Section 13390 – Packaged Control Systems.
   d. The MCP shall utilize a 120 VAC non-UPS power source for providing power for all other panel appurtenances.
   e. Master Control Panel shall contain a dedicated PLC.
      1) Provide PLC hardware in accordance with Section 13390 – Packaged Control Systems.
         a) Programming shall be done using the latest version of Schneider Electric EcoStruxure Control Expert (Unity Pro) programming software, unless otherwise directed by Owner.
         b) See Section 13390 – Packaged Control Systems for additional requirements.
   f. The Ethernet switch inside the panel shall be provided in accordance with Section 13390 – Packaged Control Systems and 17600 – Distributed Control System.
   g. Main circuit breaker:
      1) As specified in Division 17.

2) Door-mounted operator:
    a) Pad-lockable in the off position.
3) Disconnects all power to the panel.
4) Interlock with the panel door.
    a) Defeat mechanism.
5) Properly sized for the available fault current as calculated in accordance with Division 17.

h. Control power:
1) Primary voltage: 120 VAC, 1 phase, 60 hertz.
2) Control and status points to the facility SCADA system: 120 volt.
3) Secondary voltages:
    a) Additional voltages as required by the application.

i. Control components:
1) Terminal strips:
    a) Provide terminal strips for landing all external wiring.
2) Relays, timers, and other components as required providing the specified functionality and remote monitoring connections.

j. Control system programming:
1) Programming – The Supplier shall be responsible for preparing, writing, and testing all logic associated with the Master Control Panel.
2) The Supplier shall be responsible for attending a programming meeting with the Programmer prior to beginning the program process. The purpose of the meeting will be to review the Programmer requirements for coordination between Supplier and Programmer.

k. Control Devices:
1) The Master Control Panel shall be provided with start and stop (with lockout), and hand-off-auto control of the entire UV system.
2) A separate Hand-Off-Auto switch shall be provided on each Power Distribution Center (PDC).
3) At a minimum, the UV control system shall have the following inputs:
    a) Remote START/STOP via Plant PLC system.
    b) UVT (Ultraviolet Transmittance) input (from Supplier supplied UVT analyzer), with hand input override from the OIU or SCADA.
    c) Flow value from SCADA.
    d) High and Low Water level input from Supplier supplied water level measurement instruments.
    e) UV Intensity Isolated analog 4 to 20 mA or 0 to 5 VDC input (from Supplier supplied UV Intensity sensor), one per bank.
    f) Hand input operational UV dose from OIU or SCADA.

l. Dedicated OIU.
1) Provide Modicon OIU Software to support Modicon OIU.
2) The OIU shall provide access to all status and control functions for operations personnel. With password access to limit change options dependent on authority. It shall also provide access to diagnostic information, e.g., I/O status, and all PID and control functions for the commissioning engineer to allow changes to be made with appropriate password without the need for a programming terminal.

3) Provide and program the local OIU Panel in accordance with Section 13390 – Packaged Control Systems.

2.03 OPTION A: DESIGN, CONSTRUCTION AND MATERIALS – WEDECO, A XYLEM BRAND, DURON SYSTEM

A. System Manufacture and Construction:
   1. The UV disinfection system shall be manufactured by Xylem.
   2. System shall include automatic mechanical cleaning, master control panel, power distribution centers (two per channel), and accessories as specified.

B. Lamp Array Configuration:
   1. The lamp array configuration shall be a staggered inclined arrangement.
   2. The single array pattern shall be continuous and symmetrical throughout the reactor.
   3. The system will be designed for complete submersion of the UV lamps under all flow conditions including both electrodes of the lamp arc. Both lamp electrodes shall operate at the same temperature and be cooled by the effluent.

C. UV Lamps:
   1. Lamps shall be low-pressure, high-output amalgam type.
   2. The lamp filaments shall be pre-heated prior to striking of the arc in order to promote lamp longevity.
   3. Each lamp shall be tested in UV output, lamp current and lamp voltage from supplier. All results shall be stored in a database referencing to the individual batch number. The lamp batch number shall be printed on the lamp surface.
   4. Lamps will be operated by electronic lamp ballasts with variable output capabilities ranging from approximately 50 percent to 100 percent of nominal power.
   5. The filament of the lamp shall be clamped design, significantly rugged to withstand shock and vibration.
   6. Lamps shall not produce any ozone.
   7. Each lamp base shall incorporate a dielectric barrier or pin isolator. The pin isolator shall consist of a non-conductive divider placed between the lamp pins to prevent direct arcing across the pins in moist conditions. The barrier shall be dielectrically tested for 2,500 volts.

D. UV Modules:
   1. The UV modules shall be designed for submergence without causing failures or damage to the system or components. Lamp ballasts for powering UV lamps shall be located in electrical enclosures located away from the channel.
   2. All electrical connectors and motors located on the UV module and above the nominal channel water level shall either rated at NEMA 6P (IP67) or located within NEMA 6P (IP67) enclosures suitable for temporary submersion.
   3. Each UV module shall be equipped with an interlock switch that will automatically disconnect power to its associated UV bank if the module is raised from the UV channel or the quick disconnect plug is removed.
   4. The UV module design and mounting shall provide plug and socket quick disconnect facilities enabling non-technical personnel to carry out lamp replacement, wiper insert replacement, etc. without the need for any tools or specialist isolation procedures.

5. Lamp shall be removable with the quartz sleeve and wiper system remaining in place.
6. The UV lamp sleeve shall be a single piece of clear fused quartz circular tubing, which shall not be subject to degradation over the life of the system.
7. The lamp socket shall be centered against the inside of the quartz sleeve and shall be retained by a cap nut with a ribbed exterior surface providing a positive handgrip for tightening/loosening without the need for any tools. This connection includes a self-contained O-ring, sealing the lamp and socket module (independently from the quartz sleeve).
8. Each module shall be designed to allow lifting from the operating position in the channel to a maintenance/storage position above the channel using an integral electric motor.
9. Actuation mechanism(s) for lifting the module from that channel shall be driven by an electric motor.

E. Automatic Cleaning System:
1. Each UV module shall be equipped with an automatic wiping system with selectable wiping frequency.
2. Each wiping system shall include stainless steel brushes.
2. The cleaning system shall maintain uniform wiping tension and clean the quartz sleeve over the lamp's complete arc length.
3. The wiping system shall be controlled by the UV system controller and provide a fully automatic, unattended operation.
4. The number of wiping strokes per interval shall be factory preset to 2 strokes for optimum effect, with time intervals being user adjustable.
5. Actuation mechanism for the automatic wiping system shall be driven by an electric motor integral with the UV module.
6. When in the raised position, all module wetted components shall be accessible.
7. The wiper system shall have the capability of being operated in either manual or automatic mode. In automatic mode, the cleaning wipers shall be initiated and controlled by the operator interface.
8. Provide two NEMA 4X enclosures with necessary pushbutton to operate the cleaning system locally, in accordance with Section 13390 – Packaged Control Systems, and Section 17200 – Instrumentation and Control Cabinets and Associated Equipment. The cleaning system enclosures shall be located outdoors and shall be designed to operate in environmental conditions outlined in Division 01.
9. Lift System:
    a. Provide necessary lift system for each UV module.
    b. Provide two NEMA 4X enclosures with necessary pushbutton to operate the system locally, in accordance with Section 13390 – Packaged Control Systems, and Section 17200 – Instrumentation and Control Cabinets and Associated Equipment.
    c. The lift system enclosure shall be located outdoors and shall be designed to operate in environmental conditions outlined in Division 01.

F. UV Intensity Detection System:
1. A submersible UV sensor shall continuously sense the UV intensity produced in each bank of UV modules.

2. The sensor shall be according to ÖNORM M 5873-1 and shall measure only the germicidal portion of the light emitted by the UV lamps as measured at 254 nm.
3. The UV intensity monitoring system shall be calibrated in the factory. When the sensor is being used for dose pacing, the UV Supplier shall supply an additional spare intensity sensor for reference checks (in addition to number listed in spare parts).
4. The measured UV intensity signal shall be fed into the Master Control Panel and used for continuous monitoring and control of the UV dose. In automatic mode, the UV Control System shall automatically adjust the lamp power to draw the minimum electrical power while maintaining the dose setpoint.
5. The UV intensity shall be displayed on the operator interface as an absolute value in mW/cm^2.
6. The sensor shall be automatically cleaned at the same frequency as the lamp sleeves to prevent fouling of the UV sensor.
7. The UV sensor design shall be such that sensor removal can be easily conducted without removal of the UV module from the channel.
8. There shall be one (1) UV sensor for every UV bank.

G. Electrical:
1. Each UV bank shall be powered from the Power Distribution Center.
2. Each lamp ballast shall drive 2 low-pressure, high-output lamps.
3. Power factor shall not be less than 98 percent.
4. Supplier to supply all cabling between the lamps and lamp ballasts.
5. Electrical supply for the water level transmitters and switches will be provided by the Master Control Panel or the Power Distribution Center.
6. Electrical enclosures located outdoors and shall be designed to operate according to environmental conditions outlined in Division 01.
7. Harmonic distortion shall be measured with all UV banks in all channels at 100 percent rated load in accordance with a general system classification meeting the recommended maximum harmonic distortion levels in IEEE 519-2014 Tables 1, and 2 and as specified in Section 1.05 at the PCC. If these levels cannot be achieved at the installed site, the Supplier shall furnish and install all necessary active filters as manufactured by TCI or Schneider Electric series AccuSine filters to comply with IEEE 519-2014 at no additional cost to the Owner.

H. Power Distribution Center (PDC):
1. Electrical supply to each of Power Distribution Center shall be 480/277 Volts, 3-phase, 4-wire (plus ground) connection.
2. Two independent PDC's shall be provided per UV channel.
3. Each PDC shall house all control gear, and electronic ballasts associated with two UV banks.
4. PDC enclosure material shall be primed, power-coated steel - NEMA 12.
5. All Power Distribution Centers to be UL approved or equivalent.
6. Each ballast cabinet shall be equipped with a forced air cooling system and temperature monitoring that will cause the equipment within the cabinet to shut off if the internal temperature surpasses the critical limit of 122 degrees Fahrenheit.
7. An internal heater will be provided in the PDC to prevent condensation.
8. Data concentration shall be through integrated circuit boards located inside the PDC.

9. Fusing and ground detection circuits shall be located inside the PDC.
10. All PDC's shall be self-supporting.
11. Each PDC shall include its own main circuit breaker interlocked with the PDC door. The main breaker shall have a minimum interrupting capacity of 65 kA.
12. PDC's that are used to power multiple UV banks must be capable of electrically isolating the individual banks that they power.
13. Network communication with MCP over EtherNet/IP protocol.

I. Electronic Ballast:
1. The ballasts shall be electronic microprocessor controlled, designed as slot cards fitting into a rack system with a plug connector for ease of maintenance.
2. Each ballast shall drive a pair of lamps with independent control and monitoring circuits, and providing individual lamp status information to the system control.
3. The ballast shall detect lamp failure and initiate a re-strike sequence, independently from any external influence. The ballast shall attempt three re-starts before shutting off.
4. The ballast shall incorporate a galvanic separation of the two circuits. In case of the secondary circuit operating in abnormal conditions regarding voltage and/or amperage, the ballast shall shut off the lamp concerned. Equipment without this feature shall be equipped with ground fault protection.
5. The ballast shall incorporate a pre-heat circuit to heat lamp filaments prior to striking the lamp arc in order to promote lamp longevity.
6. The ballast shall be capable of varying power between 50 to 100 percent proportional to a 4-20 mA control signal.

J. Master Control Panel (MCP):
1. Control requirements are outlined in this Section and in Section 13390 – Packaged Control Systems.
2. The UV control system shall include one Master UV PLC and associated enclosure for control and monitoring of the entire UV system. The master UV PLC shall be a Modicon PLC with memory capacity per requirements outlined in Section 13390 – Packaged Control Systems and Section 17600 – Distributed Control System. The master UV PLC shall be located as indicated on the Drawings. The Master UV PLC shall be provided and programmed as specified in the Drawings, and this Section.
3. Electrical supply to the MCP shall be 120 Volts, 1 phase. Furnish an uninterruptible power supply (UPS) installed inside the PLC enclosure as required. UPS shall conform to the requirements in Section 13390 – Packaged Control Systems. Where Supplier's equipment requires other voltages, Supplier shall provide any transformers necessary for proper system operation.
4. A separate 120 VAC power source will be provided as non-UPS source to power air conditioners, fans, thermostat, and other panel appurtenances.
5. UV System control and monitoring shall be provided through display touchscreen to allow complete operator interface. Hardwired panel devices and meters shall not be permitted.
6. The Master UV PLC control panel shall be provided with a Modicon Magelis OIU with memory capacity per requirements outlined in Section 13390 – Packaged Control Systems and Section 17600 – Distributed Control System. Operator interface shall be menu-driven with automatic fault message windows appearing upon alarm conditions.

7. Bank status shall be capable of being placed either in Manual (ON/OFF) or Auto mode.
8. Banks shall be cycled in a lead/lag rotation through automatic control at the Master UV PLC for equal wear, and timed off to minimize bank cycling.
9. Elapsed time of each bank shall be recorded and displayed at the OIU when prompted.
10. Master UV PLC Panel shall be UL approved, rated NEMA 12. Panel shall be free standing.
11. Provide heating and cooling for the panel, as required. For forced air cooling, provide filters on intake openings. Provide an internal heater to prevent condensation.
12. Enclosure temperature switch:
    a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
    d. Sensor and electronic enclosure.
    e. Accuracy: Within 2 degrees Fahrenheit.
    f. Manufacturer: The following or equal:
        1) Hoffman ATEMNC.
        2) Pfannenberg FLZ.
13. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
    a. Provide as indicated on the Drawings or as specified.
14. The Master UV PLC shall be provided with all networking equipment required to properly receive and communicate information to and from the plant SCADA system.

2.04 OPTION B: DESIGN, CONSTRUCTION AND MATERIALS – TROJAN UVSIGNA 2-ROW SYSTEM

A. System Manufacture and Construction:
1. The UV disinfection system shall be manufactured by Trojan Technologies.
2. System shall include automatic mechanical/chemical cleaning, master system control panel, power distribution center, hydraulic system center, and accessories as specified.

B. Lamp Array Configuration:
1. The lamp array configuration will be in a staggered inclined arrangement.
2. The system will be designed for complete submersion of the UV lamps under all flow conditions including both electrodes of the lamp arc. Both lamp electrodes shall operate at the same temperature and be cooled by the effluent.
3. To maximize performance and ensure safety, bank light locks will be used in each bank to prevent potential short circuiting over the top of the lamps.

C. UV Lamps:
1. Lamps will be high powered low-pressure, high-output amalgam design.
2. The filament shall be significantly rugged to withstand shock and vibration.
3. Electrical connections for the lamp will consist of four (4) pins at one end of the lamp only. Lamp wiring shall be Teflon insulated stranded wire.
4. Lamps will be rated to produce zero levels of ozone.

5. The lamp shall withstand a minimum of four (4) on/off cycles per day without reducing lamp life, warranty or causing any damage to the lamp.
6. Lamps will be operated by electronic lamp drivers/ballasts with variable output capabilities ranging from 30 percent to 100 percent of nominal power. The lamp assembly incorporates active filament heating to enable operation at optimum lamp efficiency across varying water temperatures and lamp power levels.

D. Lamp Plugs:
1. Each lamp plug will be accessible from the top of the UV bank to facilitate lamp removal without moving the UV banks or any other components.
2. A light emitting diode (LED) visual indicator on the lamp plug will continuously indicate on/off status for each lamp.
3. An integral safety interlock in the lamp plug will prevent removal of energized lamps.
4. The lamp plug shall be rated NEMA 6P.

E. Quartz Sleeves:
1. Quartz sleeves will be clear fused quartz circular tubing containing 99.9 percent silicon dioxide.
2. Sleeves will have minimum UV transmittance at 254nm of 87 percent (1 mm wall thickness).
3. Sleeves will be open at one end only and domed at the other end.

F. UV Bank:
1. Each UV bank will consist of UV lamps, quartz sleeves and an automatic mechanical/chemical cleaning system.
2. Each lamp will be enclosed in its individual quartz sleeve, one end of which will be closed and the other end sealed by a lamp end seal.
3. The closed end of the quartz sleeve will be held in place by a retaining O-ring. The quartz sleeve will not come in contact with any steel in the frame.
4. Each UV bank will contain a wall on each side to prevent possible short-circuiting at the side walls of the reactor.
5. Each UV bank will be rated NEMA 6P.
6. To minimize maintenance, equipment must be provided by the UV manufacturer to enable lifting a complete bank of lamps from the channel at once for inspection and/or servicing. When the banks are lifted out of the channel, the maximum height of both the lifting device and the bank (at the service position) must not exceed 10.4 feet.

G. Light Locks:
1. Light locks will be provided to force effluent through the UV treatment zone maximizing disinfection performance.
2. The entire length of the lamp arc will remain submerged to maximize UV dose delivered to the effluent and to prevent any UV exposure above the water free surface.

H. UV Bank Lifting Device:
1. The lifting device for UV Banks will be supplied by the UV Manufacturer.
2. An Automatic Raising Mechanism (ARM) will be designed and supplied to facilitate lifting a UV bank from the channel without use of ancillary equipment.

3. The ARM will be integrated into the UV Bank for simple and seamless operation.
4. The UV Bank will be raised from the channel for easier access and maintenance.
5. The ARM design will provide access to components without having to break electrical connections thus reducing wear on connectors.

I. Automatic Cleaning System:
1. An automatic in-situ cleaning system will be provided to clean the quartz sleeves using both mechanical and chemical methods. Wiping sequence will be automatically initiated with capability for manual override.
2. The cleaning system will be fully operational while UV lamps and modules are submerged in the effluent channel and energized.
3. To minimize maintenance, UV System will be designed such that cleaning solution replacement can be performed while the UV Bank and lamps are in place and operational in the channel.
4. Cleaning sequence frequency will be field adjustable to enable optimization with effluent characteristics.
5. Cleaning system operation will be remote auto (default) or remote manual.
6. The cleaning system will be provided with the required solutions necessary for initial equipment testing and for equipment start-up.
7. The wipers shall travel the full length of the UV lamp arc. Designs in which the wipers only travel part way along the sleeves will not be acceptable.

J. UV Intensity Detection System:
1. A submersible UV sensor will continuously monitor the UV intensity produced within each UV Bank of UV lamps.
2. The sensor shall measure only the germicidal portion of the light emitted by the UV lamps as measured at 254 nm. The sensor shall have sensitivity at 254 nm of greater than 90 percent.
3. The UV intensity sensor shall be accurate within 20 percent.
4. The UV intensity monitoring system shall be calibrated in the factory. When the sensor is being used for dose pacing, the UV System Supplier shall supply an additional spare intensity sensor for reference checks (in addition to number listed in spare parts).
5. The UV sensor shall be factory-calibrated to US National Institute for Standards and Technology (NIST). Sensors requiring field-calibration are not acceptable.
6. The sensor shall be digitally calibrated to ensure calibration accuracy.
7. Sensors will be designed such that reference sensor readings can be taken without interrupting disinfection and without removing UV lamps or sleeves.
8. The sensor shall be automatically cleaned at the same frequency as the lamp sleeves to prevent fouling of the sensor and resulting false alarms for low intensity.

K. Electrical:
1. General:
    a. Each UV bank shall be powered from the Power Distribution Center.
    b. Each lamp ballast shall drive 2 low-pressure, high-output lamps.
    c. Power factor shall not be less than 98 percent.
    d. Supplier to supply all cabling between the lamps and ballasts.
    e. UV Supplier to perform all terminations between lamps and ballasts.

f. Electrical supply for the water level switch(es) will be provided by the Master Control Panel or the Power Distribution Center.
g. Harmonic distortion shall be measured with all UV banks in all channels at 100 percent rated load in accordance with a general system classification meeting the recommended maximum harmonic distortion levels in IEEE 519-2014 Tables 1, and 2 at the PCC. If these levels cannot be achieved at the installed site, the Supplier shall furnish and install all necessary active filters as manufactured by TCI or Schneider Electric series AccuSine filters to comply with IEEE 519-2014 at no additional cost to the Owner.

L. Power Distribution Center (PDC):
1. Electrical supply to each of Power Distribution Center(s) shall be 480/277 Volts, 3-phase, 4-wire (plus ground) connection.
2. PDC enclosure material will be made of Stainless Steel - NEMA 12.
3. All Power Distribution Centers to be UL approved or equivalent.
4. Each ballast cabinet shall be equipped with a temperature control device, which will shut off this part of the UV system in case of surpassing the critical limit of 122 degrees Fahrenheit.
5. An internal heater will be provided in the PDC to prevent condensation.
6. Data concentration shall be through integrated circuit boards located inside the PDC.
7. Fusing and ground detection circuits shall be located inside the PDC.
8. All PDC’s shall be self-supporting.
9. Each PDC shall include its own main circuit breaker interlocked with the PDC door. The main breaker shall have a minimum interrupting capacity of 65 kA.
10. PDC's that are used to power multiple UV banks must be capable of electrically isolating the individual banks that they power.
11. Network communication with MCP over Modbus protocol.

M. Lamp Ballast:
1. Each lamp ballast will independently power two (2) UV lamps. Failure of one lamp will not affect operation of the other lamp.
2. The lamp ballast will be programmed-start type utilizing filament pre-heat followed by a high voltage pulse to ignite the lamp.
3. During lamp operation, variable filament heating current shall be provided according to a predetermined curve to maintain optimum filament temperature and amalgam temperature to ensure maximum lamp life and optimum lamp efficiency across varying water temperatures and lamp power levels.
4. A ground fault in the output circuit shall be detected and communicated as a warning to the external controls system while the corresponding lamp operates undisturbed.
5. Local visual diagnostic will be provided with LEDs for lamp ballast status, lamp status (on, idle, preheat, fault), power and communication status.
6. For reliability and to facilitate troubleshooting, at a minimum, the following external indicators (protections, status, warnings and alarms) shall be provided: lamp status, ballast status, ballast high temperature, input voltage out of range, lamp arc circuit open/short/out of range, lamp filament open circuit/out of range, end of lamp life (EOLL), ground fault, lamp circuit leakage (water in the sleeve), communication time-out.
7. The lamp ballast shall be capable of varying power between 30 to 100 percent of nominal lamp power.

N. Master Control Panel (MCP):
   1. Control requirements are outlined in this Section and in Section 13390 – Packaged Control Systems.
   2. The UV control system shall include one Master UV PLC and associated enclosure for control and monitoring of the entire UV system. The master UV PLC shall be a Modicon PLC with memory capacity per requirements outlined in Section 13390 – Packaged Control Systems and Section 17600 – Distributed Control System. The master UV PLC shall be located as indicated on the Drawings. The Master UV PLC shall be provided and programmed as specified in the Drawings, and this Section.
   3. Electrical supply to the MCP shall be 120 Volts, 1 phase. Furnish an uninterruptible power supply (UPS) installed inside the PLC enclosure as required. UPS shall conform to the requirements in Section 13390 – Packaged Control Systems. Where Supplier's equipment requires other voltages, Supplier shall provide any transformers necessary for proper system operation.
   4. A separate 120 VAC power source will be provided as non-UPS source to power air conditioners, fans, thermostat, and other panel appurtenances. Refer to ~~00GN28 for typical Panel wiring~~ 50N08 through 50N12 for typical UV panel interface wiring schematics. AD3
   5. UV System control and monitoring shall be provided through display touchscreen to allow complete operator interface. Hardwired panel devices and meters shall not be permitted.
   6. The Master UV PLC control panel shall be provided with a Modicon Magelis OIU with memory capacity per requirements outlined in Section 13390 – Packaged Control Systems and Section 17600 – Distributed Control System. Operator interface shall be menu-driven with automatic fault message windows appearing upon alarm conditions.
   7. Bank status shall be capable of being placed either in Manual (ON/OFF) or Auto mode.
   8. Banks shall be cycled in a lead/lag rotation through automatic control at the Master UV PLC for equal wear, and timed off to minimize bank cycling.
   9. Elapsed time of each bank shall be recorded and displayed at the OIU when prompted.
   10. Master UV PLC Panel shall be UL approved, rated NEMA 12. Panel shall be free standing.
   11. Provide heating and cooling for the panel, as required. For forced air cooling, provide filters on intake openings. Provide an internal heater to prevent condensation.
   12. Enclosure temperature switch:
      a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
      b. Sensor and electronic enclosure.
      c. Accuracy: Within 2 degrees Fahrenheit.
      d. Manufacturer: The following or equal:
         1) Hoffman ATEMNC.
         2) Pfannenberg FLZ.
   13. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
      a. Provide as indicated on the Drawings or as specified.

14. The Master UV PLC shall be provided with all networking equipment required to properly receive and communicate information to and from the plant SCADA system.

O. Hydraulic Systems Center (HSC):
   1. Electrical supply to the Hydraulic System Center shall be 480V, 3-phase, 3-wire (plus ground) connection.
   2. The HSC houses the components required to operate the automatic cleaning system and bank Automatic Raising Mechanism (ARM).
   3. HSC enclosure material will be 304 Stainless Steel (Type 4X, IP 55).
   4. The HSC will contain hydraulic power unit complete with pump, fluid reservoir, manifolds, valves and filter.
   5. All hosing and tubing shall be rubber and all piping shall be Type 316 stainless steel.

2.05 ACCESSORIES

A. Face Shields:
   1. Quantity: Three (3).
   2. Design: Block UV light wavelengths between 200 and 400 nm.

B. Water Level Sensors:
   1. A minimum of two point conductivity level switches (digital switches), provided by Supplier, shall be included for each channel and shall be as specified in Section 17380 – Field Instrumentation and Sensing Devices. One switch shall be placed downstream of the UV banks for monitoring low level. The other switch shall be placed in the inlet basin for monitoring high level. Wiring of the level sensors shall ensure that each PDC is independently operated.
   2. During manual, automatic, and remote modes of system operation, the water level sensor shall ensure that the automatic cleaning system is disabled if the water level in the channel drops below an acceptable value
   3. The number, function and type of sensors shall be as shown on the P&IDs.

C. On-Line UV Transmittance (UVT) Monitor:
   1. Provided by Supplier as the following manufacturer:
      a. Hach.
   2. General Requirements:
      a. UV transmittance meter system shall measure the UV transmittance of wastewater.
      b. Integrated in channel with the radiation source immersed in water.
      c. UV measurement device:
         1) Type 316 stainless steel, quartz or equal 1.4571/316Ti/quartz.
   3. Performance requirements:
      a. 2 percent full scale accuracy.
   4. Element:
      a. UV radiation source.
      b. UV sensors:
         1) Calibrated selectivity greater than 90 percent at 254 nanometer. Non-aging, temperature stability up to 70 degrees Celsius for continuous operation.
      c. UV transmission measurement range: 0 to 100 percent.
      d. No battery backup required.

e. Neither pump nor pipe work required.
f. Direct in-channel measurement without the need of a filter.

5. Transmitter:
   a. NEMA Type 4X/IP65 thermoplastic cabinet with instrumentation window.
   b. Wall mounting.
   c. Display of UV transmission (percent).
   d. Analog output, selectable 0 to 20 milliamperes (mA) or 4 to 20 mA.
   e. Maximum distance to junction box: 26 feet.
      1) Power supply:
         a) 24 VDC.
      2) Outputs:
         a) Isolated 4 to 20 mA DC signal.
6. Components:
   a. Virtually maintenance free via automatic wiper system.
7. Accessories:
   a. Provide sunshades for outdoor installations.
8. Supplier shall supply all components necessary for mounting the UVT monitor as specified.

D. Bank Support Brackets:
   1. UV modules shall be suspended/supported on Type 316 stainless steel brackets. The support brackets shall be held in place by brackets anchored to the channel walls.

E. Inlet Baffle Plate:
   1. Provide inlet baffle on upstream end of the UV channel at location as indicated on the Drawings and as designed by the UV equipment Supplier.
   2. Design:
      a. Designed to promote plug flow to the UV banks.
      b. Located at upstream end of UV channel as shown on the Drawings.
      c. Designed to be removable with two lifting handles or eyes and structurally stiffened.
      d. Designed with round openings with approximately 50 percent porosity. The plate shall have 1-inch holes with 1.25-inch spacing.
      e. Designed with openings at the bottom of the plate to allow for solids to be hosed through to the upstream channel drain.
      f. Maximum headloss: 2.2 inches at Peak Flow.
   3. Materials:
      a. Plates: 316 stainless steel.
      g. Guides: 316 stainless steel.
      h. Anchor Bolts and Other Fasteners: 316 stainless steel.

2.06 LEVEL CONTROL WEIR

A. Supplier shall provide the level control weir as shown on the Drawings.

B. Design:
   9. The effluent level control weir shall be designed to:
      a. Maintain the minimum water surface elevation as required for each Suppliers' equipment.
      b. The UV Disinfection System meets the hydraulic constraints specified herein, under all flow conditions.

c. Head over the weir shall not be greater than 2.5 inches at the Peak Flow.
d. The level control weir shall be located as indicated on the Drawings.

C. Materials:
10. Weir: 316 stainless steel.
11. Supports, Anchor Bolts and Other Fasteners: 316 stainless steel.

2.07 INSTRUMENTATION AND CONTROLS

A. General:
1. Drawing References:
a. 50N03
b. 50N12
c. 50N13
d. 50N14
e. 90N02
2. Equipment tags:
a. UV Bank No. 1: FLTR-UVBANK-01
b. UV Bank No. 2: FLTR-UVBANK-02
c. UV Bank No. 3: FLTR-UVBANK-03
d. UV Bank No. 4: FLTR-UVBANK-04
e. UV Transmittance Meter: FLTR-UV-AIT-01
f. UV Bank No. 1 Intensity Sensor: FLTR-UV1-AIT-01
g. UV Bank No. 2 Intensity Sensor: FLTR-UV2-AIT-01
h. UV Bank No. 3 Intensity Sensor: FLTR-UV3-AIT-01
i. UV Bank No. 4 Intensity Sensor: FLTR-UV4-AIT-01
j. UV Channel Level Sensor: FLTR-UV-LS-01
k. Plant Water Distribution Flow Meter: FLTR-NPWI1-FIT-01
l. Plant Water Recirculation Flow Meter: FLTR-NPWI2-FIT-01
m. Parshall Flume Effluent Flowmeter: FIT-0900, FIT-0901.
3. Network communication between the UV system and the Plant SCADA system shall be by means of Type 2 fiber optic cable as shown on the network architecture drawing on sheet 50N04.~~Network communication between the UV system and the existing Plant SCADA system shall be provided via an Ethernet connection. A separate Ethernet connection shall be used for PLC communications to the Power Distribution Centers, if required.~~ AD3
4. All instrumentation used in the UV disinfection system control or monitoring shall be individually fused or circuit breaker protected to minimize the effects of any single point of failure.
5. The Supplier shall design, install, and program the control system in accordance with Section 13390 – Packaged Control Systems.

B. Control System and Strategy:
1. Programming – The UV Equipment Supplier shall be responsible for preparing, writing, and testing all ladder logic associated with the UV control system.
2. Components – UV Equipment Supplier will provide PLC-based master control panel with operator interface and interconnects for monitoring the system through the plant control system. The PLC outputs to the plant control system shall be via Ethernet communication. Provide all required hardware, software and programming.

3. The system's OIU for the Master UV PLC shall provide manual-auto control of entire UV system.
4. Provide a separate local-off-remote switch on each PDC enclosure. The PDC local-off-remote switch shall override the control of any other remote device.
5. UV Disinfection System monitoring and control system shall be as defined in this Section and all Division 17 sections.
6. All electrical and instrumentation and controls shall be in accordance with all Divisions 16 and 17 sections of the Specifications and meet the requirements of the Project P&IDs. Control and Instrumentation including documentation and labels shall conform to all Divisions 16 and 17 sections.
7. UV System Control Philosophy:
    a. Final control philosophies are subject to approval by the Engineer and Owner.
    b. The Master UV PLC shall control the channel of the UV disinfection system. Monitored parameters including UV transmittance, flow (via SCADA), and UV intensity shall be used to operate the channel to deliver the setpoint dose. UV transmittance shall be monitored at the influent basin of the UV disinfection process. Flow shall be monitored for the system. UV intensity shall be monitored for each UV bank.
    c. All control philosophies shall use the dose equation included in the Engineering Report of the proposed UV Disinfection System, to continuously calculate the delivered dose of the system and automatically vary the lamp power and control the system as required to minimize energy use and deliver the target dose at all times. The dose equation and control philosophy shall be as follows:
        1) Dose as a function of flow, UVT, and UV intensity sensor value, directly in agreement with Third-Party Reactor Validation Testing results and approved by the Engineer. The control system shall generate an alarm when the delivered UV dose is less than the setpoint UV dose.
        2) Operator shall have the capability of increasing the number of duty banks by one via a pushbutton on the UV OIU or SCADA. The Operator shall also be able to remove this additional duty bank from the bank sequence.
8. Control Strategy: The UV control system shall be programmed to control the UV system as follows:
    a. General:
        1) The UV control system shall monitor and control all equipment as specified herein to ensure that the target UV dose of the UV process is delivered for the given flow, UVT, and attenuated lamp conditions.
        2) The PLC program shall have the dose equation that is included in the Engineering Report of the proposed UV Disinfection System.
        3) The target UV dose shall be an operator adjustable setpoint. The allowable target UV dose shall range from 50 percent of the design dose to 200 percent of the design dose. The design dose is 23.5 mJ/cm^2.
        4) The Master UV PLC shall execute the following for the entire UV system:
            a) Monitor the system flow and UV intensity at each bank.
            b) Monitor the level in the UV channel.
            c) Calculate the UV dose delivered as specified in Articles 2.06.B.7.c and 2.06.B.8.a.2).

d) Control all UV equipment in the channel to deliver the target UV dose.
e) Control the automatic cleaning system.
f) Monitor UVT.
g) Display flow through the system.
h) Signal UV banks to start-up and shutdown as required. The operator shall be capable of selecting the bank sequence. If the online banks fail to meet the target dose, the call sequence shall automatically proceed to the next available bank. If no additional banks are available then the system shall alarm.
i) The Master UV PLC shall startup standby UV banks as required.

5) Level sensors provided must detect high and low water levels in the channel. Level sensors are wired to the PDC or the MCP.

b. Automatic Control: With all of the devices in the channel (UV banks) set to Auto mode, the operator can place the UV system into “Auto” mode from the Master UV PLC or plant SCADA. This allows the Master UV PLC to control the UV system to deliver the target UV dose:

1) General:
a) The lead bank shall always be on-line.
b) Based on the flow, via SCADA, the Master UV PLC shall select the number of banks to be in service and the required power setting of each operating bank.
c) The Master UV PLC shall automatically rotate the lead banks based on a timer. The timer shall be operator adjustable and range from 24 to 200 hours. The automatic rotation of the lead banks shall be Enabled or Disabled via a pushbutton on the appropriate OIU screen.
d) The Master UV PLC shall monitor the power level (ballast power level or lamp current) of each bank and minimize the total power required to deliver the target dose.
e) The number of ON/OFF cycles for any one UV bank shall not exceed four (4) times per 24 hours, on average.

2) Start-Up Procedure of a Bank: When a bank is required to be brought into service, the Master UV PLC will initiate the following Start-up Procedure:
a) The Master UV PLC will monitor the bank's effluent low level signal. If the low level signal is not in alarm then turn ON all lamps in the bank.
The Master UV PLC shall initiate an automatic cleaning cycle on the bank that has been placed on-line.
b) If an effluent low level alarm exists in the requested bank then generate a Major Alarm, “Low Effluent Level.”
c) If bank that was placed in service is replacing another bank then wait until the new bank has completed the lamp warm-up stage before turning OFF the lamps in the off-line bank.
The Master UV PLC shall initiate an automatic cleaning cycle on the bank that has been placed off-line.
d) After the new bank's lamp warm-up stage is completed, switch the Dose Pacing PID to Auto. The Master UV PLC shall optimize the percent ballast power level or lamp current to the UV lamps to deliver the target UV dose.

3) Shutdown Procedure of a Bank: When a bank is required to be taken out of service, the Master UV PLC shall initiate the following Shut-down Procedure to be executed by the Master UV PLC:
    a) The Master UV PLC shall calculate the new dose that will occur in the channel when the bank that is being taken off-line is completely out of service.
    b) If the number of operating banks is sufficient to treat the total flow with one less bank then the Master UV PLC will initiate the channel Shutdown Procedure detailed in item d) below.
    c) If the number of operating banks is not sufficient to treat the total flow with one less bank then the Master UV PLC will maintain the current number of operating banks and display an informational warning.
    d) Upon verification that the operating banks can deliver the setpoint dose required for the current flow then the Master UV PLC shall turn the UV lamps OFF in the bank being taken out of service.
    After the Master UV PLC has sent the OFF command to the UV lamps, the Master UV PLC shall initiate an automatic cleaning cycle on the bank that have been taken off-line.

c. Control During Filter Backwash Cycle:
    1) The Master UV PLC shall receive a filter backwash cycle signal prior to the initiation of the backwash cycle. When the backwash cycle signal is received the Master UV PLC shall force the ballast power level to 100 percent for all of the online UV banks. Dose pacing control shall be placed into manual mode and the ballast power level will not change during this period.
    2) When the backwash cycle signal is removed the Master UV PLC shall start an operator adjustable timer (initially set to 5 minutes). After the timer expires the dose pacing control will be placed into automatic mode and the Master UV PLC will determine the required ballast power level based on the operating conditions at that time.
d. Upon Major (HIGH Priority) Alarm:
    1) With the system in Auto mode, the Master UV PLC shall initiate the bank Shutdown Procedure specified herein under the following conditions after the next available bank has been placed in service:
        a) All Major alarms generated by a bank will cause the next available bank to be placed in service and the bank with the Major alarm to be placed out of service.
        b) If the Major alarm is a low level alarm then the respective Bank of lamps will automatically turn off. Any major alarm generated by the bank is a bank shutdown alarm. The next available bank is placed in service and the bank with the Major alarm is placed out of service.
        c) If another bank is not available then the bank with the Major alarm will remain on-line and the Master UV PLC will generate a Major alarm, ”Not Enough Banks Available.”
        d) If the other available banks have a Major alarm then the entire UV system, all banks, shall be placed on-line with the power to all the lamps set to 100 percent.
e. Upon LOW UVT Alarm:
    1) The UV system shall continue operating.

2) The Master UV PLC shall trigger a Low UVT alarm at Plant SCADA.
3) A Plant operator shall take a direct sample of effluent in the UV channels and shall measure the UVT with a portable UVT analyzer:
   a) If UVT measured by the UVT analyzer in the channel is verifiable by the portable UVT meter, the UV system shall continue operating without modification.
   b) If the UVT measured by the UVT analyzer is not verifiable by the portable UVT meter, the Plant operator shall, at the MCP OIU, manually input the Default UVT value to be used to operate the UV system. The operator shall then select to operate the UV system with the Default UVT at the MCP OIU or SCADA. The Default value of the manually entered UVT shall be 65 percent.

f. Upon Loss of SCADA Communication Alarm:
   1) The Master UV PLC shall trigger a Loss of SCADA Communication alarm and set the channel flow to the design peak flow rate.

g. Upon Minor (LOW Priority) Alarm:
   1) The Master UV PLC shall continue normal operation, monitoring and controlling the equipment as needed to deliver the target dose.

h. Power Failure:
   1) Power Failure as Indicated by Power Failure Relay PLC Inputs.

i. Power Failure Recovery:
   1) Following a power failure, loss of power at all PDC's, the plant Master UV PLC shall initiate communications with all of the PDC's and restore the last state of operation prior to the power failure or energize all the duty banks.
   2) The number of duty banks placed online after a power failure can also be based on an operator adjustable start-up flow.

j. Out-of-Service (Maintenance) Mode:
   1) When Out-of-Service mode is initiated at the Master UV PLC, the Master UV PLC shall execute the Shutdown Procedure as described in Article 2.07.C.8.b.3):
      a) In Auto mode, the lead banks must remain on-line.
      b) If there are an insufficient number of banks to treat the total flow then the Shutdown Procedure shall not continue.
      c) If there is sufficient number of banks to treat the total flow then the Shutdown Procedure shall continue.
      d) If the requested bank is a duty bank then generate the message, "Requested Bank is not Available".
      e) If the requested bank is a redundant bank in the channel and is offline then place that bank in Out-of-Service mode. This will allow plant maintenance staff to make minor repairs in the bank without having to rotate the duty banks.
   2) While in Out-of-Service mode, the UV control system shall disregard all alarms associated with that bank and treat the bank as off-line with respect to monitoring and reporting values.

k. Water Level:
   1) During Manual and Automatic modes of system operation, the Master UV PLC shall ensure that the lamps in the channel extinguish automatically if the water level in the channel drops below an acceptable value. The acceptable water level is specific to each UV system and shall be specified by UV Manufacturer.

2) During Manual and Automatic modes of system operation, the Master UV PLC shall ensure that the automatic cleaning system is disabled if the water level in the channel drops below an acceptable value specified by the UV Manufacturer.

l. With the UV system in Manual mode, the UV system shall be operated through the local Master UV PLC OIU or Plant SCADA:
   1) The operator shall have the ability to manually turn banks ON and OFF.
   2) The Master UV PLC shall continue to monitor the UV lamps and dose in manual mode.
   3) The safety devices shall continue to act as permissives in Manual mode to prevent any potential damages to the UV system.

m. Alarms and Monitoring:
   1) Provide OIU alarms and monitoring required as specified herein and on the P&IDs, and transmit all monitored information and alarms to the plant SCADA system.
   2) All analog alarm values (setpoints) shall be operator adjustable via the UV OIU and via the plant SCADA system.

n. Monitoring and Controls:
   1) Bank ON/OFF status for each bank, status, and action.
   2) Lamp Status and Alarm for each bank:
      a) ON.
      b) OFF.
      c) WARM-UP.
      d) FAILED.
      e) ADJACENT LAMP FAILURE.
      f) MULTIPLE LAMP FAILURE.
   3) UV Intensity (each bank), setpoints and value.
   4) Elapsed time per bank.
   5) Lamp run time for each lamp with the ability to reset counter, individually or all lamp timers within a bank.
   6) Number of starts per lamp.
   7) Cumulative number of ON/OFF cycles (each bank).
   8) Ballast power (lamp current) setpoint and value (each bank).
   9) UV transmittance value.
   10) Provide the operator the ability to override the UVT analyzer value and manually enter the UVT value based on laboratory testing.
   11) Setpoint UV dose.
   12) Flow rate.
   13) Filter backwash cycle status.

o. Major (High Priority) Alarms:
   1) Module FAIL (circuit breaker/GFI trip).
   2) Bank FAIL to energize.
   3) UV Sensor Out of Range (intensity sensor reading is greater than ±20 percent of the validated intensity value at the current operating conditions).
   4) LOW Dose (delivered RED dose drops below an operator adjustable setpoint accessible at the Master UV PLC or from the SCADA).
   5) Channel HIGH Water Level.
   6) Channel LOW Water Level.
   7) Not Enough Banks Available FAIL.

8) Adjacent Lamp FAIL (2 or more adjacent lamps fail), include location of lamps by bank and position.
9) Multiple (Percent) Lamp FAIL (more than operator adjustable percentage setpoint lamps fail per bank). Default setpoint will be 5 percent.
10) Power Fail. Alarm generated from external dry contact provided from the MCP.
11) Loss of UV Intensity Signal at PDC.
12) Loss of UV Transmittance Signal at MCP.
13) Communication Fail, Master UV PLC to SCADA.
14) Communication Fail, Master UV PLC to UV PDC's.

p. Minor (Low Priority) Alarms:
1) UV Sensor Warning (intensity sensor reading is greater than ± 15 percent of the validated intensity value at the current operating conditions).
2) LOW UVT (UV transmittance drops below an operator adjustable setpoint accessible at the UV OIU or from the SCADA).
3) Cleaning System Fail.
4) Individual Lamp FAIL (include location of lamp by bank and position).
5) Cabinet High Temperature.

q. Screen Indicators:
1) All inputs, monitoring and alarms listed in this specification must be shown visibly within the OIU screen. Additional items to be displayed on the OIU screen include:
a) Channel Flow.
b) UV Transmittance.
c) Bank ON/OFF Status.
d) Bank Manual/Automatic Status.
e) Bank Warming-up/Operating Status.
f) Bank Elapsed Time.
g) Individual Lamp Run Time.
h) Number of starts per Bank.
i) Dose Indication.
j) UV intensity sensor indications (for each bank).
k) Ballast Power Level.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of the UV equipment shall be by the Contractor in accordance with the Contract Documents, and Supplier's engineering drawings and instructions. Supplier shall supervise the installation of the UV equipment. The Contractor, in accordance with the Contract Documents and the Supplier's engineering drawings and instructions, shall install the equipment provided by the Supplier.

3.02 FACTORY ACCEPTANCE TESTING

A. Develop factory testing plan that meets the requirements of Section 01756. Testing shall include the following:
   1. Hardware check including visual inspection, ground test, short-circuit test, incoming power test, component test, and other procedures.
   2. Short-circuit (high-potential) test shall be done at one of the following voltage levels: 1. AC: 2 times operating voltage + 1000 V for 60 seconds, or 2. DC: 1.414 times the AC value from item 1 for 60 seconds.
   3. Testing after power up including input/output signal test, lamp status test, automatic operation test, cleaning and wiper (as applicable) test.
   4. OIU screen review and data test. This includes review of all timers and setpoints.
   5. Plan shall note any modification required if the testing needs to be conducted virtually rather than in person.

B. The Owner or Owner's representatives shall participate in virtual witness testing activities. This participation shall serve as a learning experience for operations and maintenance personnel. Times and dates of testing activities to be coordinated between Owner/Owner’s representative and Supplier.

3.03 FIELD EQUIPMENT CHECKS

A. Equipment Checks: Prior to the Field Testing (as detailed below, including Hydraulic, Alarm and Functional Testing, Electrical Testing, Initial Performance Test, and other testing), the Supplier shall check that all equipment is installed properly and functions as specified herein. The equipment checks shall include, but not be limited to:
   1. Proper installation and alignment of UV support structure defined as the concrete channel containing the UV banks and associated mounting brackets.
   2. Water tightness of all submerged equipment.
   3. Proper placement of UV lamp banks to assure specified water levels relative to the lamps.
   4. Electrical wiring and connections.
   5. Proper operation of instrumentation, alarms, and operating indicators associated with the UV equipment.
   6. Proper placement and operation of lamp driver/ballast and other equipment in the control panels.
   7. Adequate cooling of the control panels.
   8. Proper operation of lamp bank shut-off switches and ground fault circuit interrupters.

B. Upon completion of equipment checks, the Supplier shall submit to the Owner written certification that all UV equipment and accessory equipment associated with the UV disinfection system have been properly installed, are in good condition, are functioning properly, and are in accordance with the Contract Documents.

3.04 FIELD TESTING

A. Following the Supplier's calibration of instruments, the Supplier shall perform Component, System, and Operational Tests on the UV Disinfection Equipment System. It is the responsibility of the Supplier and Contractor to jointly coordinate and arrange the times for testing and startup activities; however, the Contractor must confirm that these times are acceptable to the Owner.

B. Calibration:
   1. Approximately 180 days prior to the Initial Performance Test, the Supplier shall calibrate all instrumentation associated with the performance testing.
   2. If retesting is required, the Supplier shall recalibrate instruments associated with the retest if they have not been calibrated within the previous 240 days and submit that information to the Engineer prior to retesting.

C. Data Collection:
   1. Direct readings from the instruments shall be used in the calculations to determine conformance with the guaranteed performance requirements.
   2. Readings shall be obtained from digital trends from the UV Disinfection Equipment System PLC and by manually recording the values directly from the instrument.
   3. Record (and round if necessary) to the level of accuracy of the instrument before any calculations.
   4. Collect manual instrument readings at 4-hour intervals during the Initial Performance Test and at 0.5-hour intervals during the Average Power Consumption Test.
   5. There shall be no adjustment to readings or calculations due to random or systematic instrumentation error or accuracy limitations.
   6. The Supplier shall document all modifications, changes, or additions and amend the operations and maintenance manuals and record drawings to reflect the modifications.
   7. All modifications required as a result of Initial Performance Test failure must be completed within 60 days of the start of the original testing period.

D. Retesting: The Supplier shall be responsible for all retesting. Supplier shall recalibrate all instrumentation associated with the retest in accordance with this Section, if the instrumentation has not been calibrated within the 60 days immediately prior to the retest:
   1. Reimburse the Owner for all Owner's costs associated with the retesting, including engineering fees and administration costs.

3.05 HYDRAULIC, ALARM AND FUNCTIONAL TESTING

A. After the Owner accepts the Supplier's written certification of proper installation of the UV Disinfection System as specified herein, the Hydraulic, Alarm and Functional Testing shall be performed to determine whether or not the equipment meets the hydraulic, alarm and control function conditions specified herein. Separate protocols for the Hydraulic Testing and the Alarm and Functional Testing shall be submitted to the Engineer for approval a minimum of 30 days prior to the scheduled UV system startup:
   1. Hydraulic, Alarm and Functional Testing will occur over a period of several days and shall be performed by the Supplier with the assistance of the Owner.

2. Channel Level Control Tests: Water level in the channel shall be measured and plotted showing flow rate in MGD on the horizontal axis and water level in inches of water on the vertical axis. The level between the downstream bank of lamps and the weir shall be used to verify the level data compared to the Supplier's specifications. A minimum of four water level measurements shall be taken during this test at approximately 25, 50, 75, and 100 percent of the design peak flow rate per channel.
3. Headloss Tests: Headloss through the channel shall be measured and plotted on a curve showing flow rate in MGD on the horizontal axis and headloss in inches of water on the vertical axis. The level upstream of the first bank of lamps and the level downstream of the last bank of lamps shall be used to verify the estimated channel headloss specified in Attachment 1 of this Section. A minimum of four headloss measurements shall be taken during this test at approximately 25, 50, 75, and 100 percent of the design peak flow rate per channel.
4. Alarm and functional testing shall include simulation of flow and water quality change, lamp and bank failures, sensor performance alarms and the proper maintenance of the minimum UV dose over a range of flow and water quality conditions, in accordance with this specification. This test shall also include automatic control of the UV banks and channels, start-up and shutdown of UV banks, bank rotation based on timers, operator selection and high priority alarms, and other control functions detailed in Article 2.06.

3.06 INITIAL PERFORMANCE TEST

A. Following completion of the Hydraulic, Alarm and Functional Testing and calibration of all instruments, the Supplier and the Contractor shall conduct the Initial Performance Test (IPT). The IPT shall be conducted to determine whether or not the equipment meets the Performance Test Requirements specified herein.

B. Supplier shall submit a detailed protocol to be followed for the IPT at least 21 days in advance. This protocol requires written approval by the Owner/Engineer before initiating the tests. The protocol shall specifically detail the operational mode of the system, sampling program, method and schedule, equipment and system monitoring data to be collected with each sampling, the daily (manual) log format, and all sampling and analytical procedures. Upon acceptance of the protocol by the Owner/Engineer, the Supplier shall commence the performance test. The Supplier shall collect and process duplicate influent and effluent samples 2 times per day for E. coli. Additional samples shall be collected for total suspended solids and UV transmittance for each test.

C. The Supplier and the Contractor shall provide the IPT Report within 10 working days of completion of the test period.

D. To perform the test, the Supplier and the Contractor shall operate the system continuously over a 5-day test period, and collect and summarize data to demonstrate that the system meets the following Performance Test Requirements:
   1. Net Production Capacity: System meets average daily flow and peak flow rate requirements as defined in this specification.
   2. Minimum Design Dose: System can deliver the minimum design UV dose as defined in this specification.

3. UV Disinfected Effluent Water Quality: UV Disinfection system produces an effluent in complete compliance with requirements as specified in this specification.
4. Cleaning: The on-line, automatic cleaning system cleans the lamps as thoroughly and frequently as is required for the system to deliver the minimum design dose at all times. The cleaning system maintains the Sleeve Fouling Factor.
5. Chemical Cleaning: One UV bank shall be chemically cleaned at the end of the IPT period. This cleaning shall restore the UV sleeves to its state of cleanliness at the onset of the IPT test. This shall be quantified by comparing the UV intensity measured at this bank at the onset of the IPT and after the chemical cleaning.
6. No major changes in equipment or apparatus will be permitted during this test period. However, minor adjustments of equipment that would normally be expected during regular operation of the equipment in plant use may be made.

E. Successful completion of the IPT shall be defined as continuous operation over the IPT test period without a major failure in the system and demonstration that system meets all performance requirements established herein. Downtime resulting from Owner's operation will not be counted against the criteria of "continuous days of operation." If an individual train has a production capacity below 75 percent of its design production capacity for more than 12 hours, the IPT will be considered a failure.

F. If during the IPT, the system fails or shuts down, the IPT shall then be rerun, as described above, and additional testing, labor, materials, equipment, etc., associated with correcting deficiencies in the UV system, including the repeated performance test, shall be borne by the Supplier. Each repetition of the IPT shall be for a continuous period unless failure to meet performance requirements as defined in this specification has been documented and modifications have been accomplished.

G. During the IPT, the Owner shall have the option of collecting samples for independent analyses to confirm measurements and analyses conducted by the Supplier and the Contractor. The Engineer and the Owner shall have the option of witnessing all testing performed by the Supplier and the Contractor. The Supplier shall notify the Engineer a minimum of 2 weeks in advance of testing.

H. If the UV Disinfection Equipment System fails to successfully complete the IPT, the Supplier shall have the option of repeating the test two more times, with all costs borne by the Supplier.

I. Consequences to the Supplier for failure to successfully complete the IPT are specified are listed in Article 1.09.A.6.d.

3.07 ELECTRICAL ACCEPTANCE TESTS

A. Electrical Acceptance Tests: Verification of warranted power consumption shall be documented by electrical acceptance testing performed by the Supplier with the oversight of the Engineer. This acceptance testing is separate and independent from the operational acceptance test described above:
1. Electrical acceptance test shall consist of consecutive 2-hour measurement of kW usage and power factor on the UV bank(s) by the Supplier.

2. Test Protocol: Banks or Modules of the UV system shall be operated with all lamps in operation at 100 percent power. During this acceptance test, the power consumption, power factor and harmonic values at maximum power shall be measured at the PCC and continuously recorded using a power meter/analyzer (provided by the Supplier for the duration of electrical testing):
    a. The meters each shall provide accuracy of ±0.25 percent, shall operate at frequencies between 47 to 63 Hz, and shall be furnished with a statement from the meter Supplier attesting to its accuracy. The meters shall be connected to the PCC at a location acceptable to the Owner. In the event that Supplier disputes results of the electrical acceptance testing Supplier shall bear the entire cost of retesting by a third party mutually acceptable to Owner and Supplier.
3. The electrical acceptance test protocol shall be submitted to the Engineer for approval a minimum of 21 days prior to the scheduled test commencing.
4. If maximum power consumption exceeds the values provided in Attachment 1 (at the end of this Specification), the Supplier shall make any and all modifications necessary to cause the system to meet the requirements, all without any additional cost to the Owner and meet the requirements of the Power Consumption Guarantee specified in Article 1.09.B.
5. If the power factor is less than that as specified herein, the Supplier shall provide any modifications necessary to adjust the power factor to meet the required power factor.
6. Measure the voltage and current harmonics at the PCC, as defined in Article 1.05.E.3 herein, for a period of 2 hours under full load conditions. The harmonic testing report shall include the following data recorded every 30 minutes after lamp warm-up is completed:
    a. Total harmonic distortion.
    b. The largest individual harmonic distortion component.
    c. The calculated short-circuit to demand current ratio using measured demand current.
    d. Total demand distortion.
    e. The harmonic distortion contribution of the odd harmonic orders as shown in Table 2 of IEEE 519-2014.

3.08 TRAINING OF OWNER'S PERSONNEL AND SUPPORT SERVICES

A. General Requirements:
1. Provide operations and maintenance training for items of mechanical, electrical and instrumentation equipment. Utilize Supplier's representatives to conduct training sessions.
2. Coordinate training sessions to prevent overlapping sessions.
3. Provide Draft Operation and Maintenance Manual for specific pieces of equipment or systems prior to training session for that piece of equipment or system.
4. Satisfactorily complete Hydraulic, Alarm and Functional Testing before beginning operator training.
5. Following Owner’s acceptance of Certificate of Proper Installation, the Supplier shall perform a comprehensive training of Owner’s personnel at the site or a classroom designated by the Engineer.
6. The training provided by the Supplier’s representative shall consist of both classroom and field training based upon Owner's schedule.

7. The Supplier shall give the Owner a minimum of 30 days' notice prior to initiation of training.
8. The Supplier shall designate and provide one or more persons to be responsible for coordinating and expediting training duties. The person or persons so designated shall be present at all training coordination meetings with the Owner.
9. The Supplier's coordinator shall coordinate the training periods with Owner personnel and shall submit a training schedule for each component of the UV Disinfection Equipment System for which training is to be provided. Such training schedule shall be submitted not less than 30 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

B. Specific Requirements:
1. In addition to the time necessary to complete the requirements established elsewhere within these Specifications, the Supplier's representative shall also provide onsite services at times designated by the City, for the minimum person-days listed below, travel time excluded.
2. Installation Supervision and Inspection: Minimum 5 person-days to handle various requests by the City, including during the unloading of UV disinfection equipment system (assume one trip) and for providing installation assistance for the UV Disinfection Equipment System (assume one trip),
3. Start-Up and Field-Testing: Minimum 10 person-days to handle various requests by the City, for assistance during startup activities (assume two trips).
4. Operator Training: Training shall consist of a minimum of total of 16 hours (two separate trips) of hands-on lectures on the UV Disinfection Equipment System operation and the maintenance requirements, including lamp chemical cleaning and replacement and repair processes for lamps, ballasts, wipers, sleeves and ancillary equipment. Training shall take place before the Initial Performance Test and six (6) months after Substantial Completion. The field training shall cover all shifts.
5. Maintenance Service – Service Scheduling:
    a. By City request any time during warranty period as specified on the Warranty Form.
6. Factory representatives of the Supplier who have complete knowledge of the proper operation and maintenance of the equipment, shall be provided to instruct representatives of Owner on the proper start-up, operation, and maintenance.

C. The Supplier shall include in proposal a price for the time and expenses listed above.

D. The Supplier's representative shall be a qualified individual who has previously provided onsite services for the installation, testing, and startup of the Supplier's identical system at a minimum of five wastewater treatment plant of similar size.

E. Telephone: Include the following in lump sum price:
1. Provide telephone support by means of a toll-free phone number for a minimum period of 3 years following installation and startup.

2. Provide a list of three or more names of individuals qualified to support operation, and provide cell phone numbers for these individuals. At least one of the listed individuals shall be available at all times including nights, weekends, and holidays in the event of an emergency.

F. Service Scheduling:
   1. By Owner, on request any time during warranty period as specified.
   2. Factory representatives of the Supplier who have complete knowledge of the proper operation and maintenance of the equipment, shall be provided to instruct Owner on the proper start-up, operation, and maintenance.

Attachment 1 Minimum Equipment Requirements		
Parameters	**WEDECO Duron**	**Trojan UVSigna 2R**
Design Factors:		
End of Lamp Life Factor	0.85	0.86
Fouling Factor	0.90	0.94
Configuration:	**Wild Horse Ranch WWTP**	
Number of Channels	1	1
Number of Duty Banks/Channel	3	2
Number of Standby Banks/Channel	1	1
Total Number of Banks/Channel	4	3
Number of Modules/Bank	1	1
Number of Lamps/Module	12	10
Total Number of Lamps	48	30
Number of UV Sensors	4	3
Number of Power Distribution Centers	2	1
Number of Master Control Panels	1	1
Total Power Consumption (kW)	33.5	32.1
Headloss across UV Banks (inches)	2.7	2.7
Lamp Type	**Low-Pressure /High-Output**	**Low-Pressure /High-Output**
Lamp Input, W/lamp	600	1,000
Guaranteed Lamp Life, hours	14,000	15,000

END OF SECTION

[AD3] Addendum No. 3

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SECTION 11294C

FABRICATED STAINLESS-STEEL SLIDE GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Slide gates and accessories.

B. As specified in Section 01600 - Product Requirements

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C560 - Cast-Iron Slide Gates.
   2. C561 - Fabricated Stainless Steel Slide Gates.

B. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code-Stainless Steel.

C. ASTM International (ASTM):
   1. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   2. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
   3. D4020 - Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

1.03 DESIGN REQUIREMENTS

A. Except as modified or supplemented in this Section, all gates and operators shall conform to the requirements of AWWA C561, latest edition.

B. Gates:
   1. Design gate slides, frames, and yokes with a minimum safety factor of 5 for tensile, compressive, and shear stresses under design seating and unseating heads specified.
   2. Design gates to meet seating and unseating heads specified in the Slide Gate Schedule. Modify gates as necessary to meet specified design requirements.
   3. Gates shall meet leakage requirements of AWWA C 561 latest edition.

C. Slide: Maximum deflection under design seating and unseating head shall equal ~~1/320~~1/720 of span. AD2

D. Yoke: Maximum deflection under design seating and unseating head and at full operating load shall equal l/360 of span.

E. Stem:
   1. Maximum slenderness ratio shall not exceed 200.

2. Maximum diameter: Provide stem guides at a spacing to maintain stem diameter of 2 inches or less.
3. Compressive strength shall equal a minimum of 2 times the rated output of the bench stand.

1.04 SUBMITTALS

A. Submit as specified in City of Austin Section 01300 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Vendor operation and maintenance manuals: As specified in City of Austin Section 01730 - Operation and Maintenance Manuals.

E. Commissioning submittals:
1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

F. Product data:
1. Wall thimbles.
2. Manufacturer's installation instructions.
    a. Include installation and adjustment instructions from gate manufacturer for every type of gate.
3. Layout and installation drawings for each gate size and type.
4. Complete bill of materials.

G. Calculations:
1. Calculations and design data substantiating conformance with the drawings and specifications.
2. Gate operators: As specified in Sections 13446 - Manual Actuators and 13447 - Electric Actuators.
3. Provide certification from both the motorized operator manufacturer and the gate manufacturer confirming that the proposed gate stem configuration has been coordinated with motorized operator selection.
    a. Confirm that the proposed gate stem configuration provides the most efficient combination of stem diameter, pitch, and lead.
    b. Confirm the design will keep the operating temperature at the stem nut to a minimum during operation.
    c. Confirm the design will meet the specified motorized operator operating speed requirements.
4. For coordination purposes, gate manufacturer shall supply calculations verifying the suitability of the selected motorized operator for the application. For each gate include:
    a. Open/close speed as specified in Section 13447 - Electric Actuators.
    b. The maximum torque required for operation of the gate (including breakaway from seat) with a safety factor of 1.4.

c. The torque supplied by the motorized operator scheduled in Section 13447 - Electric Actuators for the operating speed specified in Section 13447 - Electric Actuators.
d. The thrust output capacity of the motorized operator with the furnished motor.

5. Submit calculations and design data substantiating conformance with the drawings and Specifications.
a. Gate opening and closing thrust forces that will be transmitted to the support structure with operator at extreme positions and load.
b. Torque required to open and close the gate, including maximum torque at any point along gate travel. Indicate thrust valve and stem factor.
c. Breakaway torque from seat. Indicate thrust valve and stem factor.

H. Factory markings:
1. Mark gates according to the schedule numbers when such numbers are used.
2. Where thimbles, frames, and other components are not interchangeable, match mark components.
3. Assembled gates: Shop inspected and adjusted before shipping.

1.05 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
1. Waterman Ind., Inc., Model R.
2. Rodney Hunt Co., Series 700.
3. H. Fontaine, Series 20.
4. Hydro Gate Corp.
5. WACO Products

B. Operators and anchor bolts: Provided by slide gate manufacturer.

2.02 MATERIALS

A. Stainless steel, ASTM A276, Type 316:
1. Components or structural shapes which are welded:
a. Materials: Type 316L stainless steel.
b. Manufacturer's shop welds, welding procedures, and welders:
1) Qualified and certified in accordance with the requirements of AWS D1.6.

B. Neoprene, ASTM D2000, Grade 2 BC 510.

C. Ultra-high molecular weight polyethylene, ASTM D4020.

2.03 COMPONENTS

A. Gate slide: Fabricate using Type 316 stainless steel plate with welded structural shapes reinforcement.

B. Frames: Guides, invert members and yokes welded to form 1-piece:
   1. Material:
      a. Type 316 stainless steel.
      b. Capable of providing true dimensions within tolerances and preventing binding and excessive wear of sliding parts.
   2. Mounting: Embedded or face-mounted as scheduled in Slide Gate Schedule on drawings.
   3. Guide length: Sufficient to retain at least 2/3 of gate slide when gate is in fully open position.
   4. Additional supports: Not required in members above operating floor.
   5. Yoke to support bench stand operator: Form by 2 angles welded to gate frame.
   6. Yoke arrangement: Capable of allowing removal of slide.

C. Stem:
   1. Material: Type ~~304~~ 316 stainless steel. AD2
   2. Diameter: Capable of withstanding anticipated opening and closing thrusts under head as indicated on the Drawings.
   3. Length: Capable of permitting easily installation and removal.

D. Frame seals:
   1. Self-adjusting, ultra-high molecular weight polyethylene or adjustable J-bulb seals around perimeter of gate slide.
      a. Use only J-bulb seals when an unseating head condition exists.
   2. Hold seals in place by Type 316 stainless steel bar and fasteners.
   3. Set seals to be slightly compressed with slide in closed position.
   4. Seals shall be fully field adjustable and replaceable.
   5. Provide invert seal for all downward (weir) gates.
   6. Provide top seal for all standard upward opening gates.

E. Bottom seal:
   1. Resilient neoprene or Buna N seal compressed by closing action of gate slide against stop plate for all standard upward opening gates.
   2. Fasteners: Type 316 stainless steel.

F. Operators: As scheduled in Slide Gate Schedule on drawings and as specified in Section 13446 - Manual Actuators.

G. Anchor bolts: Type 316 stainless steel of sufficient quantity and length to anchor the gate.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners, as specified in Section 15050 - Common Work Results for Mechanical Equipment.

3.02 INSTALLATION

A. Install equipment as indicated on the Drawings and as specified in Section 15050 - Common Work Results for Mechanical Equipment and the manufacturer's written installation instructions.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      a. Installation: 1 trip, 2 day minimum.
      b. Functional Testing: 1 trip, 2 day minimum.
   3. Training:
      a. Maintenance: 2 hours per session, 1 session.
      b. Operation: 2 hours per session, 1 session.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Functional testing:
   1. Slide gate:
      a. Test witnessing: Witnessed.
      b. After installation and checking, run each gate through at least 2 full cycles from closed position to fully open and back to closed position.
      c. Conduct leak test in accordance with AWWA C560.
      d. Verify functionality of all switches and controls.

3.04 SLIDE GATE SCHEDULE

3.05 SCHEDULE

A. The Slide Gate Schedule is included on the following page(s). The Slide Gate Schedule is not a take-off list. Contractor shall provide additional gates per specifications and as indicated on the Drawings.

FABRICATED STAINLESS-STEEL SLIDE GATE SCHEDULE													
Gate Tag Number or Mark Number	Drawing Number	Area #	Opening Size W X H (inches)	Wall Opening Shape	Gate Opening Direction	Type of Closure[1]	Gate Design Pressure[2]		Gate Mounting[3]	Type of Frame[4]	Stem Type[5]	Type of Operator[6]	Minimum Gate Travel (inch)
							Seating (feet)	Unseating (feet)					
HW-BS1-SG-01	20M01	20	36” x 48”	Rectangular	Upward	FB	3’		EMB	SC	RS	HW	30”
HW-BS2-SG-01	20M01	20	36” x 48”	Rectangular	Upward	FB	3’		EMB	SC	RS	HW	30”
HW-BS1-SG-02	20M01	20	36” x 48”	Rectangular	Upward	FB	3’		EMB	SC	RS	HW	30”
HW-BS2-SG-02	20M01	20	36” x 48”	Rectangular	Upward	FB	3’		EMB	SC	RS	HW	30”
HW-GB1-SG-01	20M01	20	36” x 48”	Rectangular	Upward	FB	1.5’		EMB	SC	RS	HW	30”
HW-GB2-SG-01	20M01	20	36” x 48”	Rectangular	Upward	FB	1.5’		EMB	SC	RS	HW	30”
HW-GB1-SG-02	20M01	20	36” x 48”	Rectangular	Upward	FB	1.5’		EMB	SC	RS	HW	30”
HW-GB2-SG-02	20M01	20	36” x 48”	Rectangular	Upward	FB	1.5’		EMB	SC	RS	HW	30”
AB-FLB1-SG-01	31M01	31	34” x 36”	Rectangular	Upward	STD		1.3’	FM	SC	RS	HW	30”
AB-FLB2-SG-01	31M01	31	34” x 36”	Rectangular	Upward	STD		1.3’	FM	SC	RS	HW	30”
AB-FLB3-SG-01	31M01	31	34” x 36”	Rectangular	Upward	STD		1.3’	FM	SC	RS	HW	30”
AB-FLB4-SG-01	46M01	46	26” x 28”	Rectangular	Upward	STD		0.8’	FM	NSC[7]	RS	HW	24”
AB-FLB5-SG-01	46M01	46	26” x 28”	Rectangular	Upward	STD		0.8’	FM	NSC[7]	RS	HW	24”

FABRICATED STAINLESS-STEEL SLIDE GATE SCHEDULE													
Gate Tag Number or Mark Number	Drawing Number	Area #	Opening Size W X H (inches)	Wall Opening Shape	Gate Opening Direction	Type of Closure(1)	Gate Design Pressure(2)		Gate Mounting(3)	Type of Frame(4)	Stem Type(5)	Type of Operator(6)	Minimum Gate Travel (inch)
							Seating (feet)	Unseating (feet)					
AB-FLB6-SG-01	46M01	46	26” x 28”	Rectangular	Upward	STD		0.8’	FM	NSC(7)	RS	HW	24”
AB-FLB7-SG-01	46M01	46	26” x 28”	Rectangular	Upward	STD		0.8’	FM	NSC(7)	RS	HW	24”

Notes:

(1) Closure: DO = Downward Opening; FB = Flush Bottom; STD = Standard. See Typical Details P718 and P720 for additional installation details.
(2) Gate design pressure applied at centerline of gate.
(3) Mounting: FM = Face Mounted; EC = Inside Existing Channel; EMB = Embedded; SP = Spigot back; FWT = "F" Wall Thimble; EWT = "E" Wall Thimble; See Typical Details P716 and P717 for additional installation details.
(4) Frame: SC = Self-Contained; NSC = Non-Self Contained; F = Flatback; FL = Flange back.
(5) Stem: RS = Rising Stem; NRS = Non-Rising Stem.
(6) Operator: CO = Hand crank operator with 2-inch AWWA nut for portable operator; HW = Handwheel; HC = Hand crank; MO = Motor Operator; MOD = Modulating Motor Operator; HO = Hydraulic Operator; MHO = Manual Hydraulic Operator (Hand Pump); BS = Bench Stand; FS = Floor Stand; IFS = Interconnect Floor Stand; PS = Pedestal Support.
(7) Provide yoke-mounted pedestal (torque tube) to transfer thrust from operator to gate frame.

END OF SECTION

AD2 Addendum No. 2

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PART 1: GENERAL

1.1 Scope of Work

Furnish and install submersible, non-clog raw sewage pump(s) as specified herein and as shown on plans. The lift station pumps shall be designed to meet Phase 1 and Phase 2 conditions with the replacement of impellers. Only Phase 1 impellers shall be provided under this project. Pumps provided under Phase 1 shall be equipped with motors sized for Phase 2 conditions, so that only impellers need to be replaced to meet Phase 2 conditions. AD2

1.2 Related Specifications

Refer to Section 17101 Specific Control Strategies and Section 17100 Process Instrumentation and Control Systems (PICS) for Submersible Lift Stations controls.

1.3 Applicable Standards and Specifications

TCEQ 30TAC Chapter 317

All pump/ motor assemblies shall be designed, constructed, and tested according to the latest applicable sections of AFBMA, AISI, ANSI, ASTM, Hydraulic Institute, IEEE, NEC, NEMA MG-1, NFPA, and UL standards. Requirements listed in the drawings and specifications are considered additional to the standard requirements listed above.

1.4 Acceptable Manufacturers

A. Flygt
B. KSB
C. Flowserve

1.5 Submittals

A. Submittals

The Contractor is to submit the following information for approval by the Engineer and Owner prior to start of fabrication of the pumping units.

1. Pumps
   a. Name of pumping unit Manufacturer.
   b. Pump model number.
   c. Rotating speed.
   d. Proposed impeller size.
   e. Maximum impeller size to fit proposed pump case.
   f. Minimum impeller size to fit proposed pump case.
   g. Performance curves for like unit showing total dynamic head, capacity, and horsepower from shutoff to beyond the minimum

operating head at operating speed. Curves for Phase 1 (1.5 mgd ADF) and Phase 2 (2.25 mgd ADF) shall be provided.

h. List of materials used in the construction of the pumps. Designate materials using ASTM Standards.
i. Type of wear rings and materials for impeller and case wear rings.
j. Type of pump bearings (radial and axial).
k. Type of mechanical seal and materials of construction.
l. Outline drawing of pumps showing exterior dimensions of pump.
m. Net weight of pump.
n. Net weight of base plate.

2. Motor
   a. Motor manufacturer's name.
   b. Type of motor and/or motor enclosure type.
   c. Insulation class and type.
   d. Temperature rise over 40ºC ambient.
   e. Service factor.
   f. Frame size.
   g. Rated horsepower.
   h. Full load speed, rpm.
   i. Operating voltage, volts at 60 Hz.
   j. Locked rotor current, amps and/or letter code.
   k. Full load current, amps.
   l. Starting inrush magnetizing current, % of full load, amps.
   m. Complete outline drawing showing overall dimensions, location of terminal boxes, mounting provisions, and lifting provisions.
   n. Sectional drawing of motor showing all components and a list of materials for each component per ANSI, ASTM, NEMA.
      1) Frame/ enclosure
      2) Stator.
      3) Rotor/ shaft.
      4) Bearings.
      5) Paint or coatings.
   o. Net motor weight.
   p. Motor shaft diameter at all points.
   s. Motor stator winding resistance, ohms.

B. Operation and Maintenance Manuals

The contractor shall submit the following information for approval by the Engineer and Owner prior to equipment start-up.

1. Assembly, installation, alignment, adjustment, and checking instructions.
2. Lubrication and maintenance instructions.
3. Guide to "trouble shooting".
4. Parts list and predicted life for parts subject to wear. Parts

list should also list part numbers.

5. Recommended spare parts list.
6. Certified dimensional drawings.
7. Sectional Drawings showing arrangement of internal components.
8. Certified performance curves showing total dynamic head, capacity, and horsepower from shutoff to beyond the minimum operating head at operating speed.
9. All information supplied in the submittals.

C. Certified Report

Furnish 3 copies of a report prepared by the Manufacturer's technical representative certifying satisfactory installation, operation, and in-service placement of units.

1.6 Warranty

For new lift stations, warranty shall begin upon **FINAL** acceptance of the station. For existing stations, warranty shall begin following successful completion of the field testing and acceptance of the pump/motor assemblies.

A. The pumping unit Manufacturer shall warrant the entire pump unit against faulty or inadequate design, improper assembly and erection, defective workmanship and materials, and leakage, breakage, or other failure.

B. The Manufacturer shall furnish a written warranty agreeing to furnish and install FOB Austin, Texas at their own expense, any part of the pumping unit proving defective within twelve (12) months of the acceptance of the unit.

C. The Manufacturer shall also provide a full parts and labor warranty for the motor, its components, and its accessories for one year, and an extended pro-rated 5 year warranty.

1.7 Manufacturer Services

Furnish the services of the Manufacturer's technical representative to check installation, assist Contractor in field testing, start-up testing, making adjustments, and instructing operators and contractor in maintenance and operation procedures.

A. Motor Compatibility

The manufacturer shall ensure that the motor included with the drive is compatible with driven equipment and complies with these specifications.

B. Efficiency and Cost Effectiveness

The most efficient and cost effective premium efficiency motor shall be selected for continuous duty operation in wastewater lift stations.

1.8 Design Standards

The minimum pump efficiency at design pumping rate shall be as follows:

GPM	Min Eff. @ <50' TDH	Min. Eff.@ 50' to <100' TDH	Min. Eff. @ >100' TDH
<100	40%	30%	20%
100-500	60%	40%	30%
500-1000	65%	65%	60%
1000-5000	65%	65%	65%
>5000	70%	75%	75%

Should pump manufacturers not be able to meet or exceed the above table for a specific pumping condition, a submittal with complete verification data will be required prior to acceptance of a lesser efficient pumping unit.

PART 2: PRODUCT

2.1 General

Detailed in this specification are the design, construction and testing of submersible non-clog pump/motor assemblies suitable for sewage service.

2.2 Construction and Materials

A. Pump

1. Volute
   The pump volute, motor, and seal housing shall be high quality gray cast iron, ASTM A-48, minimum of Class 30. Outside of the volute shall be coated to prevent corrosion.

2. Shaft
   The pump shaft shall be constructed of solid stainless steel.

3. Bearings
   The solid pump and motor shaft shall be rigid and kept in correct alignment by bearings. The pump shaft shall rotate on two bearings. The upper bearing shall be a single deep grove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Bearings shall be anti-friction having a minimum B10 bearing life of 150,000 hours and designed to withstand all stresses to

ensure a long service life. Bearing houses are to be designed so that water cannot enter housing. Bearings shall be permanently lubricated.

4. Impeller

Pump impellers shall be enclosed non-clogging type constructed of a minimum ASTM A48 Class 30 cast iron minimum or of bronze. The impeller may be factory trimmed to meet specific performance conditions. Impellers shall be hydraulically balanced at the factory. Wear or field trimming shall not deter the factory balance. The impeller shall be keyed, not screwed or pinned to the shaft and shall be readily removable without the use of a special tool. The impeller shall be locked against rotation in any direction by a stainless steel or bronze impeller nut. The impeller shall be statically and dynamically balanced for smooth performance. Where conditions allow, the impeller shall be an open-type self cleaning impeller complemented by a relief groove in the volute allowing a self cleaning flow path through the pump.

LS-PUMP-01 through 05 (5 pumps) shall be supplied with a chopper ring. Chopper system shall be a hard-iron chopper insert ring by Flygt, or equal. Hydraulic performance may be tested without chopper insert installed.

5. Wear Rings

When required, the pump impeller and the adjacent casing surface shall be fitted with replaceable non-corrosive metal wear rings installed to prevent rotation.

6. Mechanical Seals

The pump shall be protected from leakage at the point that the shaft passes through the pump casing by mechanical seals. Mechanical seals must meet the following requirements:

a. The seal shall be a double mechanical seal in a cast iron seal housing constructed in two sections with a registered fit.
b. The housing shall be recessed into the pump back head.
c. The seal shall be constructed of tungsten carbide.
d. The upper and lower seal assemblies shall operate in a lubricant reservoir that lubricates the lapped seal faces at a constant rate.
e. Each seal interface shall be held in place by its own spring system.

7. External Hardware

All external wetted hardware shall be 316 stainless steel.

8. O-Rings

All O-rings shall be made of Buna N Rubber or approved equal.

B. Motor

This specification details the materials and construction for a submersible pump and motor assembly.

1. Construction

The motors shall be constructed as an integral part of submersible pump/ motor assemblies. Each motor shall be electrically and mechanically suited for the pump to which it shall be applied. The motor shall be compatible with the pump to which it shall be applied and the motor shall operate efficiently, without overheating or abnormal vibration. The motor shall be designed to provide a 20 year life. Motor shall be capable of continuous operation without relying on external fluid contact for cooling. The motor chamber shall be fitted with moisture/leak detector for signaling chamber's breach for water.

2. Motor Rating

Motor shall be Underwriters Laboratories (UL) or Factory Mutual (FM) approved as explosion proof. Rated voltage shall be per contract drawings. Motor shall be rated with a Class B temperature rise. The motor shall comply with NEMA Standard MG-1 and associated ASA and IEEE Standards unless specifically amended hereafter. Motor shall be inverter duty rated.

3. Motor Housing

Motor shall be constructed of a minimum ASTM Type A-48 Class 30 Cast Iron. The housing shall be coated for corrosion resistance.

4. Rotor and Stator

Stator windings shall be copper. Rotor may be machined, rigid, one-piece aluminum or steel core with a machined or pressure cast or brazed solid end copper or aluminum ring connection. Rotor shall be a dynamically balanced single unit. Rotor shall be removable without disassembling stator. Rotor shall be solidly attached or keyed to the motor shaft.

5. Shaft

The motor shaft shall be constructed of solid stainless steel.

6. Bearings

   See Pump section, above.

7. Insulation

   Motors shall be UL listed for Class H insulation operating temperature. The temperature rise criteria of 115°C over 40°C ambient shall be determined by resistance method or RTD's. Method of testing shall be listed in the motor submittal.

8. Motor Power/ Control Wiring and Cable
   a. Motor power lead wires shall be permanently and thermally connected to the stator for structural strength.
   b. Motor lead wires shall be connected to the power cable in a watertight chamber and appropriate watertight seal cable entrance. Pump motor power cable shall be oil and watertight, rated for continuous submerged service. Cable conductors shall be copper, sized and rated per N.E.C. Cable shall be sized using 125 % of motor nameplate.
   c. Motor control conductors for thermal and moisture leak sensory shall be rated for continuous submerged service and shall be run in a separate jacketed cable and conduit from the power cable.
   d. Power cable shall include a dedicated ground conductor. All conductors shall be permanently identified at both ends.
   e. Power/control cable shall be of sufficient length as designated with pump order to allow required power and control termination.

9. Motor Starting

   Motors sized 75 hp and above shall be reduced voltage auto transformer type sized for starting on the 65 % tap and accelerating to full speed from the reduced voltage start without overheating or otherwise causing damage to the motor windings or bearings.

10. Motor Over-temperature and Moisture Protection
    a. Motor shall have a stator winding over-temperature (OT) sensory or switch device to detect high temperature and provide shutdown protection. The OT device shall be rated and set to actuate providing protection and reaching the limits of the Class H insulation. OT sensory shall actuate in the vicinity of 25-30°C before the limits of Class H insulation rating and reset dead band of about 15-20°C. The pump/motor manufacturer shall furnish applicable OT sensory components and a complete schematic and wiring diagram.

b. Motor shall have a moisture leak detector sensory device in the seal chamber or motor housing to detect the collection/leakage of water into the motor housing and actuate designated switch contact signals. Pump/motor manufacturer shall furnish applicable moisture sensory components and a complete schematic and wiring diagram.

C. Nameplate

1. Pump and Motor

The pump motor assembly shall have a stainless steel nameplate attached to its frame with stainless steel fasteners. The nameplate shall meet the requirements of NEMA MG-1. The following information shall be displayed on the nameplate:

a. Pump manufacturer's name.
b. Pump model number.
c. Pump serial number.
d. Rated capacity in gallons per minute.
e. Rated total dynamic head in feet.
f. Pump speed.
g. Pump bearing information.
h. Motor frame description.
i. Motor horsepower.
j. Service factor.
k. Motor speed.
l. Motor voltage, phases, and frequency.
m. Motor wiring diagram.
n. Motor amperage at full and no load.

2.3 Functional Requirements

A. Operation

1. Pumps

Pumps shall be non-clog submersible pumps capable of passing a 3-inch solid.

2. Motor

a. The manufacturer shall coordinate pump operation so that all physical and operational characteristics of the motor are compatible with the requirements of the pump.
b. The motor shall operate efficiently, without overloading, overheating, or abnormal vibration, throughout the entire range of speed and load for the specified impeller.

c. There shall be no point on the pump curves at which the motor name plate rating is overloaded, even momentarily.
d. Motor shall be capable of bi-directional rotation by changing the electrical phase connections of the motor power lead wires.
e. The motor shall be capable of up to 15 evenly spaced starts per hour.
f. The motor shall be able to operate dry without damage while pumping under load.

B. Controls

Refer to Section 17101 Specific Control Strategies and Section 17100 Process Instrumentation and Control Systems (PICS) for Submersible Lift Stations controls.

C. Performance

1. Each pump supplied shall be tested for performance prior to shipment. Testing shall be in accordance with Hydraulic Institute and NEMA MG-1 Standards.
2. The pump shall operate at a minimum of 25% below its critical shaft speed.
3. Pump's capacity shall be given in gallons per minute and feet of water.
4. The lift station's firm capacity and the number of pumps operating to achieve that capacity shall also be provided.
5. Operating and design requirements shall be listed in the Supplemental Data Sheet provided in Section 4 of this document.
6. The motor shall have normal starting torque and low starting current per specified motor design per NEMA MG-1.
7. All motors, regardless of size, shall have a minimum 1.15 service factor for continuous duty.

2.4 Tools, Spare Parts, and Accessories

A. Tools

A toolbox shall be supplied. The toolbox shall include all tools needed to maintain the pump, including any special tools. Any required metric tools shall be provided.

B. Spare Parts & Spare Pump

1. Spare gaskets and o-rings shall be provided for each pump. One spare seal shall be provided in a sealed factory container for each pump. Provide one spare set of complete over-temperature sensory components. Provide one spare set of complete moisture leak detector sensory components. Any additional spare parts recommended by the manufacturer shall be provided.

2. Furnish spare pump/motor and its accessories and appurtenances. Deliver spare pump at time of station startup and inspection. Owner's receipt of spare pump is required before granting station's final acceptance.

C. Spare Nameplates

Spare nameplates shall be provided for each pump/motor assembly to be mounted on the control panel.

D. Guide Rail System

1. Guide Rail

A guide rail system shall be used to direct the pump in proper alignment with the stationary discharge piping. Supports shall not interfere with removal of pump. The rail system and supports shall be corrosion resistant and shall be fabricated of 316 stainless steel. Guide rails for each pump must be supplied by the pump manufacturer to ensure compatibility with supplied equipment. The pump shall be easily removed for inspection or service. Personnel shall have no reason to enter the wet well. Supports shall be provided for the guide rail for every 8 feet of rail. The supports shall be evenly spaced along the length of the rail.

2. Guide Brackets

The guide brackets and hardware shall be constructed of 316 stainless steel. Guide brackets for each pump must be supplied by the pump manufacturer to ensure compatibility with supplied equipment.

E. Pump Lifting Chain

Each pumping unit shall be provided with a chain sling. The chain sling is a combination of a stainless steel cable and 3 feet of stainless steel chain, which is connected to the pump. All associated lifting hardware shall be stainless steel. The free end of the cable is connected to the top of the wet well.

F. ITT Flygt Grip-Eye System (or equivalent as provided by the pump manufacturer)

1. A forged "grip-eye" of wrought alloy steel, provided separately by the pump manufacturer to connect to the end of the lifting cable or chain of the pump lifting device.

2. The "grip-eye" shall be appropriately sized for weight of pump to be lifted.

G. Pump Wire / Cable Support

Furnish pump wire/cable support device for suspended support of pump power cables. Device shall be constructed of 316 stainless steel.

~~H. Flush Valve or Mixer~~

~~A flush valve for each pump or mixer for the lift station shall be provided per design and approved by owner on a case by case basis. Additionally, a blind flange shall be provided to facilitate maintenance and repair of flush valve. Acceptable manufacturers shall be Flygt, or approved equal.~~ AD2

~~I~~H. Hardware

All hardware, fasteners, and pump mounting bolts shall be 316 stainless steel.

~~J. Manual Crane~~

~~1. As required in the Pump Schedule.~~
~~2. Hoist material:~~
~~a. Type 316 stainless steel.~~
~~3. Winch material:~~
~~a. Type 316 stainless steel, marine grade.~~
~~4. Anchor bolts: As specified in Section 05190 Mechanical Anchoring and Fastening to Concrete and Masonry.~~
~~5. Mounting: Surface mount Type 316 stainless steel socket, off side of sump access opening as shown on Drawings.~~
~~6. Winch: Manual, adjustable boom with, safety hook, and sufficient lift for pump removal from deepest sump.~~
~~7. Hoist and winch safe load rating: Minimum 1.25 times heaviest sump pump furnished or 500 pound minimum with maximum reach, whichever is greater.~~
~~8. Anchors:~~
~~a. Flush with internal thread anchor bolt sockets at each sump and socket with allowable working load of 5 times hoist pull out tension load on anchor bolts.~~
~~9. The entire manual crane assembly shall weigh no more than 85 pounds.~~ AD2

PART 3: EXECUTION

3.1 Factory Inspection and Testing

Each pump is to be tested at the factory to determine capacity, shut-off head, rated head, minimum head (for continuous operation), required power, efficiency and as required to develop an accurate performance curve. Certified copies of a report for each test are to be submitted to the Owner. All of the above tests are to be performed in conformity with the requirements and recommendations of the Hydraulic Institute and NEMA MG-1.

Witnessing source testing is not required. Performance Testing must be conducted at a Level 1. Refer to Section 15958 – Mechanical Equipment Testing for performance test level requirements.

3.2 Field Installation and Testing

A. Field Installation

The pump/motor assembly shall be installed according to the manufacturer's recommendations.

B. Field Testing

Performance Testing must by conducted at a Level 1. Refer to Section 15958 – Mechanical Equipment Testing for performance test level requirements as well as Section 01756 – Commissioning for general information regarding field testing requirements.

C. As specified in Section 01756 - Commissioning and this Section.

D. Manufacturer services:
1. Provide certificates:
   a. Manufacturer’s Certificate of Source Testing.
   b. Manufacturer’s Certificate of Installation and Functionality Compliance.
2. Manufacturer’s Representative onsite requirements:
   a. Installation: 1 trip, 5-day minimum.
   b. Functional Testing: 2 trips, 2-day minimum each.
3. Training:
   a. Maintenance: 4 hours per session, 2 sessions.
   b. Operation: 2 hours per session, 2 sessions.
4. Process operational period:
   a. As required by Owner or Contractor.

3.3 Storage and Handling

At all times Contractor shall take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until completion of work.

3.4 Equipment Protection and Restoration

A. All equipment must be boxed, totally enclosed with plastic sheet covering and crated, or otherwise completely enclosed and protected during shipment, handling, and storage.

B. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times.

C. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage during shipment.

D. All painted surfaces which are damaged prior to acceptance of equipment shall be re-painted to the satisfaction of the Engineer.

3.5 Required Spare Parts and Accessories

A. Spare gaskets or o-rings.
B. Spare thermal overload.
C. Spare moisture sensor.
D. Motor over-current protection system.
E. Spare pump/motor assembly.
F. Manufacturer recommended spares.
G. Tools (exclusive to manufacturer.)
H. Spare Nameplates.

3.6 Schedule

Tag Numbers	**LS-PUMP-02 LS-PUMP-03 LS-PUMP-04**	**LS-PUMP-01 LS-PUMP-05**	**LS-PUMP-02 LS-PUMP-03 LS-PUMP-04**	**LS-PUMP-01 LS-PUMP-05**	**SHF-LSPUMP-01 SHF-LSPUMP-02**
General Characteristics					
Service	Influent Lift Station (1.5 mgd ADF)	Influent Lift Station Jockey Pump (1.5 mgd adf)	Influent Lift Station (2.25 mgd ADF)(1)	Influent Lift Station Jockey Pump (2.25 mgd adf)(1)	Drain Pump
Quantity	3	2	3	2	2
Maximum Noise, dBA at 3 Feet	85	Not Required	85	Not Required	Not Required
Torsional Analysis	Not Required	Not Required	Not Required	Not Required	Not Required
Minimum Pumped Fluid, Degrees Fahrenheit	32 F	32 F	32 F	32 F	32 F
Normal Pumped Fluid, Degrees Fahrenheit	80 F	80 F	80 F	80 F	80 F
Maximum Pumped Fluid, Degrees Fahrenheit	104 F	104 F	104 F	104 F	104 F
Installation Configuration	Wet Pit	Wet Pit	Wet Pit	Wet Pit	Wet Pit
Pump Characteristics					
Impeller Type	Non-clog, with chopper insert	Non-clog, with chopper insert	Non-clog, with chopper insert	Non-clog, with chopper insert	Non-clog, with chopper insert
Impeller Maximum Number of Vanes	2 blades	2 blades	2 blades	2 blades	2 blades
Pass Sphere Size, Inch	3 inches	3 inches	3 inches	3 inches	3 inches
Speed Control	Fixed	Fixed	Fixed	Fixed	Fixed
Maximum Pump Speed, rpm	1165 rpm	1765 rpm	1170 rpm	1755 rpm	1800 rpm

Tag Numbers	**LS-PUMP-02 LS-PUMP-03 LS-PUMP-04**	**LS-PUMP-01 LS-PUMP-05**	**LS-PUMP-02 LS-PUMP-03 LS-PUMP-04**	**LS-PUMP-01 LS-PUMP-05**	**SHF-LSPUMP-01 SHF-LSPUMP-02**
Minimum Pump Speed, rpm	N/A	N/A	N/A	N/A	N/A
Rated Design Point:					
Flow, gpm	2,028 gpm	559 gpm	2,537 gpm	1,010 gpm	514 gpm
Head, Feet	48.2 ft	40.8 ft	48.5 ft	43.3 ft	51.7 ft
Minimum Hydraulic Efficiency, Percent	81.1%	63.2%	78.7 %	63.8%	69.9%
Required Condition 2:					
Flow, gpm	2,380 gpm	898 gpm	2,870 gpm	1,096 gpm	350 gpm
Head Range, Feet	42.4 ft	33 ft	42.2 ft	40 ft	62 ft
Minimum Hydraulic Efficiency, Percent	80.4%	74.8%	75.9 %	64.0%	62.0%
Required Condition 3:					
Flow Range, gpm	3,056 gpm	1,282 gpm	3,053 gpm	1,354 gpm	700 gpm
Head, Feet	29.9 ft	21 ft	38.64 ft	31 ft	40 ft
Minimum Hydraulic Efficiency, Percent	70.9 %	63.7%	73.30%	61.2%	63.5%
Other Conditions:					
Maximum Shutoff Head, Feet	82 ft	57 ft	94 ft	76 ft	86 ft
Minimum NPSHa at Every Specified Flow, Feet	13.0 ft	24.3 ft	15.2 ft	25.2 ft	24.5 ft
Minimum Suction Static Head, Feet	0.8 ft	0.8 ft	0.8 ft	0.8 ft	0.5 ft
Minimum Discharge Size, Inches	8 inches	6-inch	8 inches	6-inch	6-inch

Tag Numbers	LS-PUMP-02 LS-PUMP-03 LS-PUMP-04	LS-PUMP-01 LS-PUMP-05	LS-PUMP-02 LS-PUMP-03 LS-PUMP-04	LS-PUMP-01 LS-PUMP-05	SHF-LSPUMP-01 SHF-LSPUMP-02
Motor Characteristics					
Minimum Submergence	21-inches	13-inches	21-inches	13-inches	13-inches
Maximum Driver Speed, rpm	1165 rpm	1765 rpm	1170 rpm	1755 rpm	1800 rpm
Motor Horsepower, Minimum	~~35~~ 45 hp AD2	~~12~~ 20 hp AD2	45 hp	20 hp	12 hp
Voltage/Phases/Hertz	460/3/60	460/3/60	460/3/60	460/3/60	460/3/60
Service Factor	1.15	1.15	1.15	1.15	1.15
Starting Current, Amperes	225 A	114 A	330 A	148 A	87 A
Rated Current, Amperes	42 A	16 A	55 A	26 A	12 A
Motor Efficiency (At 100-Percent Load), Minimum	89.0%	88.5%	89.5%	87.5%	70.0%
Enclosure Type	Submersible, Explosion Proof	Submersible, Explosion-Proof	Submersible, Explosion Proof	Submersible, Explosion-Proof	Submersible, Explosion-Proof
NEMA Design Type	B	B	B	B	B
Source Testing					
Test Witnessing	Not Witnessed	Not Witnessed	Not Witnessed	Not Witnessed	Not Witnessed
Performance Test Level	1	1	1	1	1
Vibration Test Level	Not Required	Not Required	None	None	Not Required
Noise Test Level	Not Required	Not Required	None	None	Not Required

Tag Numbers	**LS-PUMP-02 LS-PUMP-03 LS-PUMP-04**	**LS-PUMP-01 LS-PUMP-05**	**LS-PUMP-02 LS-PUMP-03 LS-PUMP-04**	**LS-PUMP-01 LS-PUMP-05**	**SHF-LSPUMP-01 SHF-LSPUMP-02**
Functional Testing					
Performance Test Level	1	1	1	1	1
Vibration Test Level	Not Required	Not Required	None	None	Not Required
Noise Test Level	Not Required	Not Required	None	None	Not Required
Notes: 1. Only Phase 1 (1.5 mgd ADF) impellers shall be supplied. The larger impellers for the 2.25 mgd (ADF) scenario will be purchased in the future.					

[AD2] Addendum No. 2

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SECTION 11312C

PREROTATION SUBMERSIBLE PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install duplex centrifugal submersible pumps in prerotation basin for final clarifier scum service in wet well as shown on PLANS. Pumps to be rated for range of operating points defined in “Attachment A” within manufacturer’s recommended operating range.

B. Furnish complete pumping system including pumps, controls, guide rail system, and all items required for installation. Units to be removable and all valves to be operable and serviceable without entering wet well.

1.02 RELATED REQUIREMENTS

A. PLANS show general arrangement, location, and basic dimensions. Attachment “A” to this Specification Section gives performance and design requirements.

B. Related work as called for on PLANS or specified in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES (NOT USED)

1.04 DEFINITIONS (NOT USED)

1.05 PERFORMANCE REQUIREMENTS

A. Reference Attachment “A”.

1.06 SUBMITTALS

A. Furnish in accordance with Specification Section 01300, “Submittals” and Specification Section 01730, “Operation and Maintenance Data”.
   1. Shop Drawings. In addition to the items specified in Specification Section 01300, “Submittals”, furnish the following:
      a. Certified pump curves indicating total head, capacity in gpm, brake horsepower required, efficiency and operating speed.
      b. Dimensioned installation drawings, and construction material designations by ASTM Standards.
      c. Motor design data and rating, including full load amps and kW input at rating point.
      d. Control system details including schematic, field wiring diagram, and manufacturer’s catalog data on all components and control panel arrangement.
   2. Operation and Maintenance Manuals
      a. Assembly, installation, alignment, adjustment, and checking instructions.
      b. Lubrication and maintenance instructions.

c. Guide to “troubleshooting”.
d. Parts lists and predicted lift of parts subject to wear.

B. Furnish certified report prepared by manufacturer’s technical representative certifying satisfactory installation, operation and in-service placement of units.

1.07 QUALITY ASSURANCE

A. Standardization: All like equipment to be obtained from a single manufacturer.

B. Coordination Responsibility
1. To ensure equipment compatibility, pump manufacturer to be responsible for providing pumps, motors, belts, belt guards and pump bases.
2. CONTRACTOR to retain overall responsibility for equipment coordination, installation, testing, and operation.

C. Furnish services of manufacturer’s technical representative to check installation, witness field testing, assist in making adjustments, and instruct operators in maintenance and operation procedures.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver, unload and store products on site in manner that prevents damage. Use special care to prevent damage from temperature and condensation.

B. Flanges to be protected by wooden blank flange protectors, strongly built and securely bolted thereto, or otherwise attached.

1.09 – 1.11 (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURER(S)

A. Hidrostall, LLC

B. Trillium Pumps/WEMCO

C. Or Owner/Engineer approved equal

2.02 MATERIALS AND/OR EQUIPMENT

A. General: Furnish prerotation pumping system consists of pump, motor, suction bell, and basin. The prerotation system shall conform to the following specification.

B. Pumping Unit
1. Design
a. The basic design shall be a single passage, clog free pump, utilizing a screw centrifugal impeller. The overall pump design shall combine high efficiency, low required NPSH, a large solid passage, and the ability to handle rags or other fibrous material without plugging.

b. The hydraulic design of the impeller shall combine the action of a positive displacement screw with the action of a single vane centrifugal impeller to provide a single, non-bifurcated flowstream with only gradual changes in flow direction.
    1) The leading edge of the impeller vane shall blend into the impeller body in such a way that any rag or other fibrous material caught on the leading edge and folded over both sides of the vane will be unfolded and released as the textile follows the flowstream through the pump.
    2) The impeller flange or impeller shall contain a spiral groove on the rear face so that any solids in the pumped media are discharged from the space between the backplate and the rear of the impeller.
c. In order to maintain optimum running clearances along the entire length of the impeller to maintain design hydraulic efficiencies, the geometry of the impeller and suction liner shall be conical, so any axial adjustment of the impeller will cause the clearance between the impeller and suction piece to change uniformly along the entire length of the impeller. Designs incorporating curved, or combination curved/conical impeller and suction piece are not acceptable because in such designs clearances cannot be adjusted uniformly over the full length of the impeller.
d. Suction and discharge flanges shall be drilled to meet ANSI 125 lb. bolting.

2. Materials of Construction
    a. The pump volute, backplate, and impeller flange shall be made of close-grained cast iron, ASTM A48.
    b. Replaceable suction liner shall be constructed of materials of ASTM A532 high chrome iron, minimum 450 Brinell hardness.
        1) For pumps with a shimmed liner, the suction piece or impeller shall be externally adjustable to compensate for wear by means of shims so that the necessary running clearances between the liner and impeller can be maintained for optimum hydraulic efficiency.
        2) Pumps without a separate suction liner and cover are not acceptable.
        3) All impellers shall be dynamically balanced.
    c. A stainless steel suction bell shall be provided to prevent premature vortexing of the liquid column, thereby extending the prerotation range.
    d. The hot-dipped galvanized coating shall be in accordance with ASTM A123.

C. Wet Well Mounting
    1. The manufacturer shall provide a heavy duty cast iron or fabricated stainless steel fast out fixture which shall be permanently mounted in the prerotation basin as shown on the PLANS.
    2. The fixture shall cantilever the entire pump volute and motor from the volute discharge flange, providing an unobstructed sump floor under the pump; supports from underside of pump volute or pump suction to sump floor (which could collect textiles and impede flow to pump) will not be acceptable.
    3. The fixture shall include a 90-degree ductile iron piping elbow to connect to vertical piping, and shall provide mounts for two stainless steel rails of standard schedule 40 pipe, which will guide the pump into position. Contractor shall provide the guiderail sch 40 stainless steel pipes.

4. The pump shall be supported by a positive metal-to-metal interlocking flange, which is additionally sealed by a leakproof Buna-N ring pressed against the fixture flange by the weight of the pump.

D. Prerotation Basin
   1. The prerotation system manufacturer shall provide a prefabricated prerotation basin for installation by the Contractor. The prerotation basin shall be a circular fiberglass basin of the appropriate geometry, so constructed that it can be easily filled with concrete outside the wet well by the Contractor. The manufacturer shall furnish a plate and/or discharge elbow, which both locates and secures the anchor bolts for the fast-out during the concrete pour. This plate/elbow shall also be designed so that it can be used to rotate and move the basin after filling. The basin shall be of a design that allows the basin, pump/motor and base/fast-out elbow to be pre-assembled outside the wet-well for simplified field installation. Three eye bolts shall be encapsulated in the concrete for lifting and lowering. The anchor bolts and eye bolts shall be furnished by the manufacturer.
   2. The prerotation system manufacturer shall be responsible for the design geometry and shall certify the installed basins will allow the prerotation system to meet the specified pumping criteria.
   3. After the concrete has set, the basin shall be turned over using the locator plate/elbow, the fast-out shall be mounted on the anchor bolts, and the assembly shall be lowered into the wet-well for final adjustment and grouting.
   4. Alternately, the basin shall be fitted with grout holes so that it can be located in the wet well before being filled with concrete. After being located in the wet well, the basin shall be secured to the wet well floor and the Contractor shall alternate pouring concrete around the outside of and inside the basin to ensure that the basin does not move or float during filling.
   5. The prerotation basin shall be self-cleaning and shall capture, entrain, and remove floatables and other debris from the wet well.
   6. The prefabricated basin shall be constructed of a minimum thickness 1/4” reinforced fiberglass. The coating shall be a gel coat of 9-12 mils.

E. Submersible Motors
   1. Each pump shall be furnished with a squirrel cage, induction motor enclosed in a watertight housing constructed of ASTM A48 Class 30 (GG20) and suitable for use and compatible with all variable frequency drive systems.
   2. The motor shall be suitable for wet or dry pit installation under full load conditions. Motors shall be certified for variable frequency drive systems without de-rating the motor output power. The motors shall be capable of installation in either the wet pit or dry pit installation without adding or removing any items to the motor’s interior or exterior.
   3. The motors shall be air-filled with a closed loop cooling system and constructed with moisture resistant NEMA Class H insulation and Class H slot liners and constructed to NEMA B design standards. The copper wound stator shall be dipped in epoxy enamel and hardened to withstand a temperature of 180 degrees Centigrade as defined in NEMA Standard MG-1. Each winding phase or layer shall be laced with Class H glass lined paper. The use of cable ties to restrain windings shall not be allowed. The rotor shall be statically and dynamically balanced after fabrication. The rotor shall utilize aluminum amortisseur bars and short circuit rings. The constructed motor shall be certified for continuous duty with a service factor of 1.10.

4. Motors shall be capable of sustaining 15 starts per hour (unlimited starts with VFD) at a minimum ambient temperature of 40°C.
5. Motors shall be capable of uninterrupted operation with a voltage drop of 10%.
6. The motor shall be cooled via a water/glycol medium circulated through a jacket surrounding the air-filled motor cavity. The water/glycol cooling medium shall be circulated by an impeller mounted to a secondary shaft which is driven by the main motor shaft through a bevel gear system. The entire coolant pump assembly shall be field serviceable and replaceable without disassembly of the pump. The secondary impeller's shaft shall be constructed of stainless steel and supported by two sealed bearings with housings of stainless steel and a B-10 bearing life in excess of 50,000 hours. The bevel gears shall be constructed of corrosion-resistant polyamide and steel and grease lubricated. The coolant impeller shall be separated from the motor through a silicon carbide versus silicon carbide mechanical seal and an auxiliary sealing ring.
7. The cooling medium circulation impeller shall cause the water/glycol to move through the jacket from which it picks up heat from the motor. This heat is then directed into the internal heat exchanger which transfers the heat to the pumped liquid. The heat exchanger shall be located below the sealing chamber. It shall be provided with a labyrinth design channel system such that sufficient contact time is maintained in the heat exchanger to allow for continuous pump operation without overheating. Cooling systems requiring a separate, clean water source or that circulates the pumped sewage through a cooling jacket will not be accepted.
8. The motor shall bear the FM explosion-proof label certifying its use in a Class 1, Division 1, Groups C & D (Zone 1) hazardous location.
9. Cold-type thermistors shall be furnished to control the winding temperature in the motor. The stator shall be equipped with a set of thermistors, one per phase. Thermistors shall open automatically and de-energize the motor when its temperature exceeds a preset limit as recommended by the manufacturer.
10. The pump manufacturer's nameplates shall be engraved, laser etched or stamped on stainless steel and fastened to the motor casing.

F. Shafts
1. Pump shafts shall be AISI 420 (1.4021) stainless steel. Carbon steel shafts or shafts with sleeves of any type are not acceptable. The shaft shall be one piece construction without joints or stubs attached.
2. Multiple row lower bearings for axial thrust and a single row upper bearing for radial thrust shall support the motor/pump shafts. The thrust bearings shall be designed to take the full axial load of the impeller. Bearings shall be sized to provide a minimum L-10 life of 50,000 hours anywhere on the flow versus head curve. Thrust bearings shall be restrained from thrust in both directions. Designs that do not protect the pump/motor from thrust in reverse directions shall not be acceptable.
3. All shafts shall be dynamically balanced and shall be amply sized to minimize shaft deflection. The distance from the lower bearing to the hub of the impeller shall not exceed the diameter of the shaft when the shaft diameter is measured at the lowest bearing.
4. Bearings shall be sealed and grease lubricated.
5. Minimum shaft diameter shall be 2-3/4 inches at the lowest bearing.

G. Mechanical Seals

1. Each pump shall be provided with an enclosed block mechanical seal with the seal housing and spring system constructed of AISI 316 stainless steel. The block seal housing shall be constructed such that it can be dismantled allowing the seal faces and springs to be renewed and the seal system to be put back into service. Cartridge seals constructed such that they cannot be repaired or renewed shall not be acceptable. Both upper and lower seal faces shall be silicon carbide versus silicon carbide.
2. The seal shall be mounted in a separate and isolated seal chamber. The seal chamber shall be filled with non-conductive lubricating oil as recommended by the manufacturer.
3. A moisture sensor shall be furnished to sense seal failure for each pump. This sensor shall be wired to the Pump Control Panel and shall activate an alarm light upon seal failure. The sensor probe shall be mounted in the seal chamber and shall be of the conductive type, sensing moisture intrusion above the lower seal, but below the upper seal. Designs which sense seal failure above the upper seal through the use of a float switch are not acceptable. Designs which sense seal failure above the upper seal through the use of a float switch as the only moisture sensor are not acceptable.
4. In addition to the two mechanical seals, the sealing system shall feature an auxiliary sealing ring constructed of stainless steel. The sealing ring shall be mounted above the upper seal and shall direct any moisture to a diversion chamber and away from the air-filled motor cavity. The diversion chamber shall be fitted with a float switch to indicate the presence of moisture. The float switch output shall be a redundant indication of seal failure.

H. Power and Control Cables
1. Power and control cables shall be furnished in lengths to run un-spliced from the pump to the pump control panel as shown on the Contract Drawings and as specified herein. Cables shall terminate with conductor sleeves that bundle the entire group of strands of each phase to improve termination at the pump control panel. The sleeves shall be provided to confirm that all strands of each conductor is terminated properly. Termination shall be coordinated with the connection to the Pump Control Panel.
2. Cables shall be of the "NSSHOU" type and shall be approved by the MSHA for use in hazardous locations and shall conform to industry standards for loads, resistance under submersion against sewage, and be of stranded construction. The cables shall enter the pump through a heavy duty entry assembly which shall be provided with an external clamp assembly to protect against tension once secured providing a strain relief function as part of standard construction.
3. The cables for each pump shall pass through the strain relief component and then through a series of stainless steel disks and Buna-n grommet that is sandwiched between the disks to control compression of the grommet. The cable entry design shall be of the type recommended in the Factory Mutual Research Corporation specifications for Explosion Proof Certification. The entry shall be comprised of the cast iron fitting that will include the Buna-N strain relief grommet coupled with a poured conductor section. In the poured section, only Factory Mutual approved sealant shall be used to wick into each conductor strand that has the insulation removed in this area to provide a positively leak proof seal for the power and sensor cords.

4. The cable entry system shall terminate in line-up terminals constructed to allow exchange of the power cable through the use of only a standard screwdriver.

I. Controls
   1. Main Control Panel
      a. Contractor to furnish and install integrated control panel for pumping system. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include pump controls, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings. Control panel shall be provided in accordance with Specification Section 17200, “Instrumentation and Control Cabinets and Associated Equipment”.
      b. Design: Factory-wired and tested control panel designed to function with Scum pumping units. For each individual pump, control panel functions as defined on the Electrical and Instrumentation & Control Drawings.
      c. Operation of pumps shall be as defined in Specification Section 17101, “Specific Control Strategies”.
   2. Field Control Station
      a. Contractor to furnish and provide field control stations for each pump as defined on the Electrical and Instrumentation & Control Drawings.
      b. Field control station shall be per Specification Section 16540, “Field Control Stations”.

2.03 FABRICATION

A. Shop Painting and Coating
   1. Per Specification Section 09960, “High Performance Coatings”.
   2. Coat pumping unit with manufacturer’s standard, but not less than one prime and one finish coat of coal tar epoxy.

2.04 SOURCE QUALITY CONTROL

A. Factory Tests
   1. The pump manufacturer to perform the following inspections and tests on at least one of the pumps before shipment:
      a. Test the pump at the factory in accordance with Hydraulic Institute Standards. The efficiency to be based on wire to water efficiency of the motor supplied with each pump. Use of the actual pump motor is required.
      b. Minimum Hydrostatic Test Pressure: 150 percent of shut-off head at maximum design speed, unless otherwise designated in Attachment” A”.
   2. If pump test does not meet performance specifications, pump manufacturer to correct deficiencies to provide the specified performance, and re-test all the remaining pumps prior to shipment.
   3. A written report stating the foregoing steps have been completed must be supplied with pump(s) at the time of shipment.

B. Warranty
   1. Control Panel, and pumps shall be furnished with manufacturer’s standard warranty (one-year minimum required).

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Pumps and motors to be installed as indicated on the PLANS and as required by the pump manufacturer's printed instructions and approved practices for installation of pumping equipment.

B. All hold-down nuts on foundation bolts to have full thread make-up.

C. After completion of all procedures specified above, clean and touch up any damaged coating system as required.

D. Lubricate and make unit ready for operation.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Service
   1. All final adjustments of equipment, controls and instruments to be performed by technicians representing the equipment manufacturers. Furnish service and training required in Specifications.

B. Field Testing: After completion of installation and prior to acceptance by the OWNER, CONTRACTOR shall demonstrate in the presence of the ENGINEER the functionality of all control panel functions and alarms.

C. Placing in Service
   1. Before Start-Up:
      a. Check impeller and make sure all rotating elements are free and clear.
      b. Check direction of motor rotation with pump disconnected to ensure the direction of pump and motor are compatible.
      c. Have manufacturer's representative inspect and approve installation.
   2. Complete unit, when assembled and operating, to be free from excessive vibration, cavitation, and noise.

3.03 MEASUREMENT AND PAYMENT

No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

A. **GENERAL**

1. Service: Secondary clarifier scum with floatable solids
2. Liquid Temperature: 35°F - 100°F
3. Number of Pumps: 4 (total)

B. **PERFORMANCE REQUIREMENTS**

Parameters		
Location	Scum Pump Station Duplex 1	Scum Pump Station Duplex 2
Quantity	2	2
Tag Number	SC-SCUMPUMP-01 SC-SCUMPUMP-02	SC-SCUMPUMP-03 SC-SCUMPUMP-04
Rated Capacity (each) (gpm)	180	175
Total Developed Head at Rated Capacity (ft)	22.6	23.0
Minimum Shutoff Head at Full Speed (ft)	35.0	35.2
Maximum Runout Point Pump Head at Full Speed (ft)	10.0	10.1
Minimum Efficiency at Rated Capacity	61.98%	61.32%
Maximum Driven Speed (rpm)	1,200	1,200

C. **SIZE REQUIREMENTS**

1. Minimum Suction Size: 4 inches
2. Minimum Discharge Size: 4 inches
3. Minimum Spherical Solids Handling Size: 3 inches

D. **MOTOR REQUIREMENTS**

1. Maximum Horsepower: 5.4 HP
2. Voltage: 480 volt, 3-phase, 60 Hz
3. Enclosure: Submersible
4. Service Factor: 1.10

END OF SECTION

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SECTION 11312D

VERTICAL TURBINE SHORT SETTING CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pump systems including vertical turbine pumps with radial type impellers and drivers as scheduled.

B. Tag numbers: As specified in Pump Schedule.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
   3. PTC 8.2 - Centrifugal Pumps.

C. American Water Works Association (AWWA):
   1. C205 - Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4 In. (100 mm) and Larger-Shop Applied.

D. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
   4. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   5. A278 - Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C).
   6. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   7. A516- Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate-and Lower-Temperature Service.
   8. A582 - Standard Specification for Free-Machining Stainless Steel Bars.
   9. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   10. B30 - Standard Specification for Copper Alloys in Ingot Form.
   11. B505 - Standard Specification for Copper Alloy Continuous Castings.
   12. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
   13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   14. F594 - Standard Specification for Stainless Steel Nuts.

E. Hydraulic Institute (HI):
   1. 2.1-2.2 - Rotodynamic (Vertical) Pumps for Nomenclature and Definitions.
   2. 2.3 - Rotodynamic (Vertical) Pumps for Design and Application.
   3. 2.4 - Rotodynamic (Vertical) Pumps for Manuals Describing Installation, Operation and Maintenance.
   4. 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, Sound Measurement and Decontamination.
   5. 14.6 - Rotodynamic Pumps For Hydraulic Performance Acceptance Tests.

1.03 DEFINITIONS

A. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 2.1-2.2, 2.3, 9.1-9.5, and 14.6 and as modified in the Specifications. The pump head and efficiency are evaluated at the outlet of the discharge head and include the net losses in the pump column and discharge head, and intake basket or strainer (when specified).

B. Flow, head, efficiency, and motor horsepower specified in this Section are minimums unless stated otherwise.

C. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric.

D. Tolerances: This Section and related sections contain tolerances that may be more stringent than Hydraulic Institute Standard tolerances. Where tolerances are not mentioned, Hydraulic Institute Standards 2.1-2.2, 2.3, 2.4, and 9.1-9.5 shall apply.

E. Allowable Operating Region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

F. Preferred Operating Region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

1.04 SUBMITTALS

A. Submit as specified in City of Austin Section 01300 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   a. Pump certification as specified in Section 01600 - Product Requirements.
   b. Weighted average lead calculations as specified in Section 01600 - Product Requirements.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Torsional analysis: Submit as specified in Section 15050 - Common Work Results for Mechanical Equipment when scheduled.

E. Vendor operation and maintenance manuals: As specified in City of Austin Section 01730 - Operation and Maintenance Manuals.

F. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or engineer approved equal:
   1. Flowserve; model as scheduled.
   2. Weir/Floway; similar to scheduled model.
   3. National Pump Co.; similar to scheduled model.
   4. Sulzer/Johnston Pumps; similar to scheduled model.

2.02 SYSTEM DESCRIPTION

A. Components: Pumps, drivers, motors, and drive arrangements as specified or as scheduled with shafts, columns, barrels, intermediate bearings, seals, couplings, base plates, guards, supports, anchor bolts, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. All required conditions (flow/head) shall be within the pump manufacturer's Allowable Operating Range (AOR).
      c. Performance tolerances shall be the same as the test tolerances specified in Section 15958 - Mechanical Equipment Testing.
      d. Pump curve shall be continuously rising throughout the design conditions listed in the pump schedule.
   2. Motor characteristics: As specified in the Pump Schedule.

C. Product requirements as specified in Section 01600 - Product Requirements and Section 15050 - Common Work Results for Mechanical Equipment.

2.03 MATERIALS

A. General:
   1. Pump Schedule materials: As specified in this Section.
   2. Drinking water pumps: Provide materials as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Cast iron: ASTM A48, Class 30 minimum.

C. Nickel cast iron: ASTM A48, minimum Class 30, cast iron with 3 percent nickel.

D. Gray iron casting: ASTM A278, Class 30.

E. Iron-chromium alloy: ASTM A743, Grade CA40; ASTM A276, Type 420 Stainless Steel may be substituted; Brinell Hardness Number of 350 to 380.

F. Lead-free bronze except for bearings that require lead for lubricity: ASTM B584.

G. Leaded tin bronze: ASTM B505, Alloy C92700.

H. Bronze or high lead tin bronze: ASTM B584, Alloy 93800.

I. Leaded red brass: ASTM B584, Alloy C83600, leaded red brass.

J. Type 416 stainless: ASTM A582, Type 416 Stainless Steel.

K. Neoprene: Polychloroprene rubber.

L. Steel: ASTM A283, Grade D or ASTM A516 Gr. 70.

M. Steel pipe: ASTM A53, Grade B.

N. Aluminum bronze meeting the requirements of Section 15050 - Common Work Results for Mechanical Equipment.

O. Lead-free aluminum bronze: ASTM B30.

2.04 GENERAL PUMP CONSTRUCTION

A. Type: Industrial, heavy duty, vertical turbine, centrifugal type pumps meeting performance requirements and features as scheduled and as specified.

B. Discharge flange: ASME B16.1 or B16.5 drilled; rated for 1.2 times the pump shutoff head at 150 degrees Fahrenheit.

C. Discharge nozzles: Provide 1/2-inch NPT taps for pressure gauges; install nipple and gauge with block valve.

D. Bearings:
   1. Design driver/motor bearings to support the line shaft assembly and rated for ABMA L10 life of 40,000 hours at Design Rated Point flow and head in accordance with ABMA 9 or ABMA 11.

2. Design motor to withstand continuous duty full load thrust and momentary up thrust that may occur during pump on/off or other operations.

E. Fasteners: Provide Type 316 stainless steel fasteners in accordance with ASTM F593 or ASTM F594.

2.05 PUMP SUCTION ASSEMBLY

A. Pump suction assembly: Provide suction bell. Provide anti-vortex baffles and strainer when scheduled.

B. Design suction bells and provide strainers and anti-vortex baffles to minimize solids plugging and vortexing. Screens to have a flow area at least 4 times the suction pipe area.

C. Materials:
1. Pump suction bell: As scheduled.
2. Anti-vortex baffles: Same material as scheduled for pump suction bell.
3. Pump suction bell bearing: As scheduled.
4. Pump suction strainer: When strainer scheduled, provide Type 316 stainless steel.

2.06 PUMP IMPELLER BOWL ASSEMBLIES

A. Pump impeller assembly:
1. Type: As scheduled.
2. Maximum number of vanes: As scheduled.
3. Number of stages: As scheduled.
4. Required balance: As specified in Section 15050 - Common Work Results for Mechanical Equipment to meet vibration criteria as specified in Section 15958 - Mechanical Equipment Testing.
5. Method of securing impellers to shafts: Keyed and secured by a bronze nut locked in place or locked by other methods acceptable to the Engineer. Provide any special tools required for removal and installation of pump impellers.
6. Provisions for adjustment of axial clearance: Make such adjustment through use of motor adjusting nut or adjustable coupling.
7. Impeller thrust: When appropriate for the specified impeller type, provide hydraulically balanced impeller to minimize down thrust.

B. Intermediate and discharge impeller cases:
1. Material: As scheduled.
2. Attached with bolting.

C. Pump impeller bowl bearings: Provide bearing for each impeller; material as scheduled.

D. Diffusion vanes: Provide vanes cast into bowl.

E. Suction bowl bearings:
1. Provide bronze sleeved bearings with self-contained lubrication system filled with graphite type non-soluble grease when grease lubrication scheduled; provide bearing with sand cap.

F. Design with smooth water passages to reduce clogging by stringy or fibrous materials on impellers or shafting.

G. Design replaceable wear rings for both the bowl and impeller on each impeller bowl.

H. Design capable of passing solids with a sphere size as scheduled or larger.

2.07 LINE SHAFTS

A. Provide line shaft type and lubrication type as specified in this Section.

B. Open line shaft, product lubricated:
   1. Shaft and couplings:
      a. Provide keyed shaft type mechanical couplings with key or set screw locking of shaft couplings.
         1) Threaded shaft connections are not allowed.
   2. Bearings and bearing retainers: Provide bearings and retainers spaced as scheduled, but not to exceed 10 feet; provide at least 1 bearing for each line shaft length; provide grease fitting for top bearing extended to outside any guards when grease lubrication specified.
   3. Materials:
      a. Shaft and couplings: As scheduled; where hard faced steel shaft is specified, hard face at sleeve bearings to 550 Brinell minimum.
      b. Bearings and bearing retainers: As scheduled; when not scheduled, Neoprene rubber bearings with bronze retainers.

C. Design strength: Able to withstand minimum 1.5 times maximum operating torque and other loads.

D. Resonant frequency: As specified in Sections 15050 - Common Work Results for Mechanical Equipment and 15958 - Mechanical Equipment Testing.

E. Sleeves: Provide shafting with Type 316 stainless steel sleeve or hardened sleeves where shafts pass through bearings as scheduled; Brinell 550 or higher for hardened shaft; when the specified mechanical seals cannot be installed on a hardened shaft, hardened shafts are not required in the area of the mechanical seal.

F. Design pump line shafting in interchangeable lengths as scheduled, but not to exceed 10 feet; shaft lengths to match scheduled pump column lengths.

G. Coupling strength: Design driver to pump line shaft coupling of sufficient length and strength to maintain line shaft alignment.

H. Adjustment:
   1. Design a means to adjust shaft position to adjust impeller position.
   2. For motor driven units with solid shaft motors, design driver to pump line shaft coupling to allow adjustment of the impeller position.
   3. For motor driven units with hollow shafts, an adjusting nut may be provided at the top of the motor shaft.

I. Spacer coupling: When mechanical seals are scheduled, provide an adjustable spacer coupling to allow removal of the seal without driver removal.

2.08 PUMP COLUMN PIPE

A. Pump column pipe: Thickness and material as scheduled.

B. Head connection: Design with flanged and bolted connection to discharge head and flanged and bolted connection to impeller assembly to permit removal of impeller bowl assembly without disturbing the column or discharge connections.

C. Design Working Pressure: Design to withstand a design working pressure not less than 1.20 times the maximum shutoff total dynamic head with the maximum diameter impeller at the maximum operating speed plus the maximum suction static head.

D. Pressure test: Design to withstand a 5-minute hydrostatic test pressure not less than 1.5 times the design working pressure; perform test at source.

E. Lengths and connections: Design with maximum 10-foot length, or less if scheduled, interchangeable column sections with flanged or threaded with registered fit screwed connections as scheduled.

F. Diameter: Design column inside diameter for no more than 4 feet of fluid friction loss per 100 feet of column length.

2.09 PUMP DISCHARGE HEAD ASSEMBLY

A. Design the discharge head for above or base discharge as scheduled.

B. Design the discharge vertical to horizontal flow transition as a smooth pipe elbow or from a minimum of 3 pipe pieces mitered to form the elbow.

C. Design discharge head to mate with the driver as scheduled.

D. Head and base plate construction: Sufficient strength, weight, and thickness to provide accurate alignment, prevent excessive deflection and support the drive motor.

E. Mechanical seals:
   1. Design the discharge head with mechanical seals as scheduled.
   2. Mechanical seal: When scheduled, provide stuffing box suitable for the specified seal and provide solid shaft motor with spacer coupling.
   3. Additional seal requirements: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

F. Discharge vent: Provide 3/4 inch NPT threaded high point vent on discharge; install pipe nipple with threaded gate valves in vent.

G. Materials: As scheduled; when not scheduled, provide:
   1. Pump discharge head/driver stand: Steel, ASTM A283, Grade B and/or ASTM A53, Grade B; or cast iron, ASTM A48, Class 30 minimum.
   2. Pump discharge head sleeve bearing: Bronze.
   3. Stuffing box and seal: Container and gland, cast iron, ASTM A48, Class 30 minimum; Neoprene top shaft seal.

2.10 EQUIPMENT GUARDS

A. Provide equipment safety guards as specified in Section 15050 - Common Work Results for Mechanical Equipment.

2.11 DRIVERS

A. Horsepower:
   1. As scheduled.
   2. Listed driver horsepower is the minimum to be supplied.
      a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.
      b. When scheduled driver is a motor, increase motor horsepower if required to prevent operation in the service factor.
      c. Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.

B. Motors: Provide motors as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower and as specified in this Section:
   1. RPM: As scheduled:
   2. Enclosure: As scheduled.
   3. Electrical characteristics: As scheduled.
   4. Efficiency, service factor, insulation, and other motor characteristics: As specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.
   5. Motor accessories: As specified in Section 16222 - Low Voltage Motors up to 500 Horsepower and in this Section.
   6. ~~Coordinate motors with the variable frequency drive manufacturer to ensure compatibility between the motor and variable frequency drive.~~ AD2

C. Other drivers: As scheduled and as specified in sections listed in the Schedule.

D. Non-reverse ratchets: When scheduled, provide driver with non-reverse ratchets or pin mechanism to prevent reverse rotation of the pump and driver in the event of discharge valve failure.

2.12 SUPPORTS

A. Strength: Design pump discharge head and driver (motor or engine) supports to withstand a minimum of 1.5 times the maximum imposed operating loads or the imposed seismic loads, whichever is greater.

B. Resonant frequency: Design supports in conjunction with the pump, shafting, drivers, bearings, and other components to avoid natural resonant frequencies, either torsional, radial, or axial as specified in Section 15958 - Mechanical Equipment Testing.

C. Coordinate pump and drive system supports with the foundation designs as indicated on the Drawings.

D. Anchor bolts: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.13 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts:
   1. Line shaft rubber bearings: 1 set for each type pump.
   2. Line shaft bronze bearings: 1 set total.
   3. Impeller and bowl wear rings: 1 set for each type of pump.
   4. Mechanical seal: 1 complete seal of each type.
   5. Motor/gear thrust bearing set: 1 total.
   6. Motor radial bearing set: 1 total (if specified).

B. Special tools: Deliver 1 set for each furnished pump type and size needed to assemble and disassemble pump system.

PART 3 EXECUTION

3.01 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 2-day minimum.
      b. Functional Testing: 2 trips, 1-day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 1 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing: As specified in the Pump Schedule.

D. Functional testing: As specified in the Pump Schedule.

3.02 PUMP SCHEDULE

Tag Numbers	**FLTR-NPWPUMP-01 FLTR-NPWPUMP-02 FLTR-NPWPUMP-03**
Application	Plant Water
Service	Non-Potable Water Pumps
Quantity	3
First Named Manufacturer's Model Number	08ELM FPD – B30
Maximum Noise, dBA at 3 feet	85
Torsional Analysis	Not Required

Tag Numbers	FLTR-NPWPUMP-01 FLTR-NPWPUMP-02 FLTR-NPWPUMP-03
Minimum Pumped Fluid Degrees Fahrenheit	50
Normal Pumped Fluid Degrees Fahrenheit	80
Maximum Pumped Fluid Degrees Fahrenheit	90
Minimum Number of Stages AD2	5 stages
Impeller Type	Enclosed
Impeller, Maximum Number of Vanes	Per manufacturer
Pass Minimum Sphere Size, Inch	~~0.5~~N/A AD2
Pump Impeller Bowl Bearing Lubrication	Product Lubricated
Suction Bowl Bearing Lubrication	Product Lubricated
Suction Strainer	Yes
Anti-Vortex Baffle	Yes
Line Shaft Type	Open
Minimum Line Shaft Bearing Spacing, Feet	5
Line Shaft Lubrication	Product Lubricated
Discharge Shaft Seal Type	Single Mechanical
Column Connection Type	Threaded
Maximum Column Section Lengths, Feet	10
Pump Barrel or Can	None
Discharge Arrangement	Above Base
Coupling Type	Flanged
Speed Control	Fixed
Maximum Pump rpm	1,785
Minimum Pump rpm	1,785
Rated Design Point:	
Flow, gpm	150
Head, Feet	210
Minimum Efficiency, Percent	73
Required Condition 2:	
Flow, gpm	100
Head Range, Feet	228 to 232
Minimum Efficiency, Percent	65

Tag Numbers	FLTR-NPWPUMP-01 FLTR-NPWPUMP-02 FLTR-NPWPUMP-03
Required Condition 3:	
Flow Range, gpm	175
Head, Feet	188 to 193
Minimum Efficiency, Percent	73
Other Conditions:	
Maximum Shut Off Head, Feet	250
Maximum NPSHr at every Specified Flow, Feet	4.2
Minimum NPSHa at every Specified Flow, Feet	34
Minimum Suction Static Head, Feet	2.5
Maximum Suction Static Head, Feet	9
Suction Bell	Cast Iron Cl 30
Suction Bell Bearing	Bronze
Impeller Cases	Cast Iron Cl 30
Impeller	Bronze
Impeller Bearing	Bronze
Impeller Shaft Key	316 Stainless Steel
Line Shaft and Coupling	Type 416 Stainless Steel
Line Shaft Bearings	Rubber
Shaft Enclosing Tube	Not Required
Shaft Sleeve	304 SS
Column Material and Thickness, Inch or Schedule	Fabricated Steel thickness 0.25”
Can Material and Thickness, Inch or Schedule	N/A
Can Lining	N/A
Can Coating	N/A
Discharge Head/Driver Stand	Cast Iron
Discharge Head Bearing	Bronze
Driver Type	Motor
Drive Arrangement	Vertical, Coupled
Non-Reverse Ratchets	Required
Minimum Driver Horsepower	15
Maximum Driver rpm	1800

Tag Numbers	FLTR-NPWPUMP-01 FLTR-NPWPUMP-02 FLTR-NPWPUMP-03
Motor Specification Section	16222
Service Factor	1.15
Motor Voltage/Phases/Hertz	460/3/60
NEMA Enclosure Type	TEFC
Winding Temperature Switch	Yes Normally Closed
Test Witnessing	Not Witnessed
Performance Test Level	1
Vibration Test Level	None
Noise Test Level	None
Performance Test Level	2
Vibration Test Level	1
Noise Test Level	1

END OF SECTION

[AD2] Addendum No. 2

SECTION 11312F

SEWAGE PUMPS, SELF-PRIMING, VOLUTE-MOUNTED

PART 1 GENERAL

1.01 SUMMARY

This Section includes the furnishing and installation of horizontal, volute-mounted, self priming, non-clog pumps for sewage service, as shown on PLANS and as specified herein.

1.02 RELATED REQUIREMENTS

A. PLANS show general arrangement, location, and basic dimensions. Attachment "A" to this Specification Section gives performance and design requirements.

B. Magnetic coupling variable speed control system shall be furnished as part of the work of this Section and shall conform to all applicable portions of Specification Section 11313, "Magnetic Coupling Variable Speed Control System for Return Activated Sludge Pumps".

C. Related work as called for on PLANS or specified in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

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

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	Standard for Load Ratings and Fatigue Life for Ball Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.5	Standard for Pipe Flanges and Flanged Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A29	Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A582	Standard Specification for Free-Machining Stainless Steel Bars

1.04 DEFINITIONS (NOT USED)

1.05 PERFORMANCE REQUIREMENTS

A. Reference Attachment “A”.

B. The pump must re-prime and deliver full capacity within five minutes after the pump is energized.

1.06 SUBMITTALS

A. Furnish in accordance with Specifications Section 01300, “Submittals” and Specification Section 01730, “Operation and Maintenance Data”.
   1. Shop Drawings. In addition to the items specified in Specification Section 01300, “Submittals”, furnish the following:
      a. Certified pump curves indicating total head, capacity, brake horsepower, efficiency and NPSH required from shut-off to beyond minimum operating head at all operating speeds and priming lift capacity.
      b. Dimensioned installation drawings, and construction material designations by ASTM Standards.
   2. Operation and Maintenance Manuals.
   3. Furnish certified report prepared by manufacturer’s technical representative certifying satisfactory installation, operation and in-service placement of units.

1.07 QUALITY ASSURANCE

A. Standardization: All like equipment to be obtained from a single manufacturer.

B. Coordination Responsibility
   1. To ensure equipment compatibility, pump manufacturer to be responsible for providing pumps, motors, belts, belt guards and pump bases.
   2. Pump manufacturer shall be responsible for providing magnetic coupling variable speed drive as defined in Specification Section11313, “Magnetic Coupling Variable Speed Control System for Return Activated Sludge Pumps” as part of a complete pumping system.
   3. CONTRACTOR to retain overall responsibility for equipment coordination, installation, testing, and operation.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver, unload and store products on site in manner that prevents damage. Use special care to prevent damage from temperature and condensation.

B. Flanges to be protected by wooden blank flange protectors, strongly built and securely bolted thereto, or otherwise attached.

1.09 – 1.11 (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURER(S)

A. WEMCO

B. Gorman-Rupp Co., Model T6C

C. Cornell Pump Company, STX Series

2.02 MATERIALS AND/OR EQUIPMENT

A. General
   1. Pump to be horizontal, volute-mounted, self-priming, non-clog, equipped with flanged suction and discharge assemblies. Units to be complete with baseplate and direct drive motor.
   2. Entire rotating assembly, which includes impeller, shaft, mechanical shaft seal, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping.
   3. Provide lifting rings or lugs on pump/baseplate for use in handling.

B. Casing
   1. Design of casing to allow removal of rotating element without disconnecting suction or discharge piping (back pullout design).
   2. Material to conform to ASTM A48, gray iron Class 30, with a minimum hydrostatic pressure of 150 psi.
   3. Volute to have smooth fluid passages devoid of blowholes and other irregularities.
   4. Suction and discharge connections to be standard 125-pound flanges per ANSI B16.5.
   5. Provide casing inspection port (handhole) with cover plate on the volute. Cover plate should be light-weight quick removable, allowing complete access to all interior passages of the pump (impeller, seal, wear-plate or check valve) without removing suction or discharge piping.
   6. Provide a replaceable untapered wear plate, made of carbon steel with a minimum hardness of 130 Brinell. The wear plate must be secured to the coverplate by 316 SS studs and hardware and to be removable without tools. The wear plate shall have a saw tooth shaped profile, to shear stringy materials as they pass through the pump.
   7. Provide casing drain at least 1” NPT to insure complete and rapid draining.
   8. Provide vent connections and discharge gauge connection. Include air bleed control device.

C. Impeller
   1. Impeller to be one-piece, two-vane, semi-open, non-clog design of cast ductile iron to withstand shock loading. Impeller to be threaded on shaft and secured with lock-nut or screw. Alternatively, impeller to be taper fit to shaft.
   2. The impeller to have integral pump out blades on back of shroud.
   3. Statically and dynamically balanced.

4. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.

D. Shaft and Seals
   1. Shaft shall be one-piece, medium carbon steel protected from liquid pumped with slip fit renewable stainless steel sleeve. Shaft should be of sufficient diameter to rigidly support the impeller and prevent excessive vibration at all speeds.
   2. Shaft seal shall be oil lubricated mechanical type Chesterton Style 442, hydraulically balanced to avoid face separation under system surge pressure. Seal to be installed out of the pumped sewage in an oil-filled housing requiring no external lubricant supply. The same oil shall not lubricate both shaft seal and shaft bearings. Stationary and rotating elements of seal to be silicon carbide.

E. Bearing Cartridge
   1. Equipped with heavy-duty oil lubricated radial and thrust bearings. Entire oil reservoir to be within bearing cartridge and to be cooled by liquid being pumped. Entire rotating element including bearings, shaft, seal and impeller to be removable as a unit from the motor end, without unbolting volute or pedestal from base. Bearing housing to be positioned within and supported entirely by pump volute.
   2. The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of seal cavity oil level and condition of oil.

F. Suction Check Valve: Molded rubber one piece, designed to be removed or installed through cover plate opening without disturbing suction piping. Sole function of the check valve shall be to save energy be eliminating need to re-prime after each pumping cycle. Pump requiring a suction check valve to assist re-prime will not be acceptable.

G. Base Plate and Drive Arrangements
   1. Shaft Coupling: Bearing housing and motor stool design is to provide accurate, self-aligning mounting for a foot type electric motor. Pump and motor shall be coupled using magnetic coupling drives per Specification Section 11313, “Magnetic Coupling Variable Speed Control System for Return Activated Sludge Pumps”.
   2. Base:
      a. Common base plate for pump, motor, and drive, cast iron, ASTM A48, Class 30, or fabricated steel, 3/8-inch minimum thickness, designed to resist torsional movement and support the combined weight of pump and motor without deflection under all loads.
      b. Provide slotted boltholes for motor mount, positioning and jacking bolts to set belt tension, or mount motor on commercial motor sliding base.

H. Electric Motor
   1. General: Motor to be non-overloading over entire operating range of pump from shut-off to run-out.
   2. Performance Requirements: Per Attachment “A”.
   3. Construction Features: Per Specification Section 16222, “Electric Motors, Induction, 600 Volts and Below”.

4. For motors smaller than those covered in NEMA MG1 Tables, provide most efficient motor possible.

I. Accessories
   1. Provide 3/8-inch bronze air relief cock at top of casing.
   2. Stainless Steel Nameplates: Attached to the pump and drive motor giving the manufacturer's model and serial number, rated capacity, head, speed, and all pertinent data.
   3. Anchor bolts, flange bolts, studs, nuts, and other pump hardware to be Type 316 stainless steel in conformity with ASTM A276.

J. Spare Parts
   1. One (1) impeller.
   2. One (1) wearplate.
   3. One (1) shaft sleeve.
   4. One (1) set of thrust bearings.
   5. Pump gasket set.
   6. One (1) shaft seal.
   7. Two (2) cup valves.

K. Controls
   1. Main Control Panel:
      a. CONTRACTOR to furnish and install integrated control panel for pumping system. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include pump controls, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings.
      b. Design: Factory-wired and tested control panel designed to function with specified RAS pumping units. For each individual pump, control panel to include control functions as defined on the Electrical and Instrumentation & Control Drawings.
      c. Operation of pumps shall be as defined in Specification Section 17101, "Specific Control Strategies".
   2. Field Control Station
      a. Contractor to furnish and provide field control stations for each pump as defined on the Electrical and Instrumentation & Control Drawings.
      b. Field control station shall be per Specification Section 16540, "Field Control Stations".

2.03 FABRICATION

A. Shop Painting and Coating
   1. Per Specification Section 09960, "High Performance Coatings".
   2. Pump, motor, speed reducer and other non-stainless-steel components to have epoxy paint finish.
   3. Apply rust-preventative compound to all machined, polished, and nonferrous surfaces that are not to be painted.

2.04 SOURCE QUALITY CONTROL

A. Factory Tests
   1. The pump manufacturer to perform the following inspections and tests on at least one of the pumps before shipment:

a. Test the pump at the factory in accordance with Hydraulic Institute Standards. The efficiency to be based on wire to water efficiency of the motor supplied with each pump. Use of the actual pump motor is required.
b. Minimum Hydrostatic Test Pressure: 150 percent of shut-off head at maximum design speed, unless otherwise designated in Attachment" A".

2. If pump test does not meet performance specifications, pump manufacturer to correct deficiencies to provide the specified performance, and re-test all the remaining pumps prior to shipment.
3. A written report stating the foregoing steps have been completed must be supplied with pump(s) at the time of shipment.

B. Warranty
1. Control Panel and pumps shall be furnished with manufacturer's standard warranty (five-year minimum required).

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Pumps and motors to be installed as indicated on the PLANS and as required by the pump manufacturer's printed instructions and approved practices for installation of pumping equipment.

B. All hold-down nuts on foundation bolts to have full thread make-up.

C. Align and level pumping unit to suction piping. Use precision levels and gauges. Final alignment to utilize a laser-type shaft alignment system performed in presence of OWNER.

D. Use wedges or shims to level, providing for grout of thickness indicated.

E. Align pump and driver following manufacturer's instructions.

F. Grout in accordance with the applicable concrete items and grout manufacturers' recommendations. Let grout set seven days before removing wedges or shims. Remove all wedges or shims. Grout gaps left by wedges or shims.

G. After grout is set, check alignment and realign as necessary. Connect piping, making sure no stresses are transferred to the pump. Make any necessary changes to piping. Check belt alignment and tension.

H. After completion of all procedures specified above, clean and touch up any damaged coating system as required.

I. Lubricate and make unit ready for operation.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Service

1. All final adjustments of equipment, controls and instruments to be performed by technicians representing the equipment manufacturers. Furnish service and training required in this Specification.

B. Field Testing: After completion of installation and prior to acceptance by the OWNER, CONTRACTOR shall demonstrate in the presence of the ENGINEER the functionality of all control panel functions and alarms.

C. Placing in Service
   1. Before Start-Up:
      a. Check impeller and make sure all rotating elements are free and clear.
      b. Check direction of motor rotation with pump disconnected to ensure the direction of pump and motor are compatible.
      c. Have manufacturer's representative inspect and approve installation.
   2. Complete unit, when assembled and operating, to be free from excessive vibration, cavitation, and noise.

3.03 MEASUREMENT AND PAYMENT

No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

A. **GENERAL**
1. Service: Return activated sludge (RAS) with suspended solids ranging between 4,000 mg/L and 15,000 mg/L.
2. Maximum Liquid Temperature: 85°F
3. Number of Pumps: 5
4. Tag Number: SC-RASPUMP-01, SC-RASPUMP-02, SC-RASPUMP-03, SC-RASPUMP-04, SC-RASPUMP-05
5. Pumps are to be direct-driven.
6. Pumps will be operated in parallel.
7. Variable capacity accomplished with adjustable magnetic drive
8. Typical Make and Model:
    a. WEMCO Model WSP6A
    b. Gorman-Rupp Co, Model T6C

B. **PERFORMANCE REQUIREMENTS**
1. First Rating Point at Full Speed:
    a. Rated Capacity: 625 gpm
    b. Total Developed Head at Rated Capacity: 17.5 feet
    c. Minimum Efficiency at Rated Capacity: 54%
2. Secondary Rating Point at Full Speed:
    a. Rated Capacity: 800 gpm
    b. Total Developed Head at Rated Capacity: 13.0 feet
    c. Minimum Efficiency at Rated Capacity: 50%
3. First Rating Point at Minimum Speed:
    a. Rated Capacity: 393 gpm
    b. Total Developed Head at Rated Capacity: 11.0 feet
4. Secondary Rating Point at Minimum Speed:
    a. Rated Capacity: 600 gpm
    b. Total Developed Head at Rated Capacity: 7.0 feet
5. Full Pump Speed Not to Exceed: 765 rpm
6. Net Positive Suction Head Available at Rated Capacity: 20 feet
7. Run-out point pump head at full speed to be less than: 10 feet
8. Shutoff head at full speed not to be less than: 40 feet

C. **SIZE REQUIREMENTS**
1. Minimum Suction Size: 6 inches
2. Minimum Discharge Size: 6 inches
3. Minimum Spherical Solids Handling Size: 3 inches

D. **MOTOR REQUIREMENTS**
1. Maximum Horsepower: 7.5 HP
2. Voltage: 480 volt, 3-phase, 60 Hz
3. Enclosure: TEFC
4. Service Factor: 1.15
5. Speed: Magnetic Adjustable Speed Drive
6. Direct drive, Inverter duty rated
7. Minimum full load efficiency: 89%

END OF SECTION

SECTION 11312J

SUBMERSIBLE PROCESS LIQUID SUMP PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Packaged submersible sump pumps, with a control panel and instrumentation.

B. Tag numbers: As specified in Pump Schedule.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   3. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

B. Hydraulic Institute (HI):
   1. 1.1-1.2 - Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions.
   2. 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application.
   3. 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, Sound Measurement, and Documentation.
   4. 11.6 - Rotodynamic Submersible Pump for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA:
   1. Type 7 enclosures in accordance with NEMA 250**.**

B. Pump head (Total Dynamic Head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 9.1-9.5 and 11.6 and as modified in this Section.

C. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

D. Allowable Operating Region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump’s vibration, noise, and cavitation are within acceptable limits.

E. Preferred Operating Region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Vendor operation and maintenance manuals: As specified in Section 01730 - Operation and Maintenance Manuals.

E. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Components: Overhung impeller, close coupled, single stage, volute style, end suction submersible sewage pump. Other items include: Control panel, level control instrumentation, discharge piping, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics: As specified in the Pump Schedule, Pump Performance Characteristics:
      a. As specified in the Pump Schedule.
      b. All required conditions (flow/head) shall be within the pump manufacturer's Preferred Operating Range (POR).
      c. Performance tolerances shall be the same as the test tolerances specified in Section 15958 - Mechanical Equipment Testing.
   2. Motor characteristics: As specified in the Pump Schedule.
   3. Suitable for pumping raw sewage.

C. Product requirements as specified in Section 01600 - Product Requirements and Section 15050 - Common Work Results for Mechanical Equipment.

2.02 GENERAL USE SUMP PUMP, TYPE 1

A. Manufacturers: One of the following or engineer approved equal:
   1. Barnes. (Crane Pumps & Systems), SE series.
   2. ITT Goulds Pumps, WS_ series.
   3. Hydromatic, SKHS series.

B. Materials:
   1. Cast Iron: ASTM A48, Class 30 minimum.
   2. Stainless Steel: ASTM A276 or equal.
   3. Buna N: ASTM D2000.

C. Pump casing:
   1. Material: Cast iron.
   2. Design Working Pressure: 1.5 times the shut off pressure.
   3. Provide support legs on sump bottom and clearance for suction entrance.
   4. The discharge connection shall be a 2 or 3-inch NPT vertical connection.

D. Impellers:
   1. Material: Cast iron.
   2. 2-vane; maximum enclosed; non-clogging; with pump-out vanes on backside; dynamically balanced; close coupled to motors.
   3. Method of securing to shafts: Threaded lock nut or similar connection.

E. Pump shafts:
   1. Material: 400 series stainless steel.

F. Bearings:
   1. Upper bearing: Single row; oil lubricated.
   2. Lower bearing: Single row; oil lubricated.

G. Shaft seal:
   1. Single mechanical seal.
   2. Materials:
      a. Silicon carbide versus silicon carbide seal faces.
      b. Carbon versus ceramic seal faces.
   3. Elastomer and hardware: Buna-N and 300 series stainless steel.

H. Finishes:
   1. Pump manufacturer to factory prime and coat pump/motor and discharge elbow.
   2. Contractor to provide touch-up field coatings as specified in Section 09960 - High-Performance Coatings.

2.03 DRIVERS

A. Motors:
   1. NEMA B design.
   2. Oil filled submersible motor.
   3. Insulation:
      a. 1.5 horsepower and above: Class B.
      b. Under 1.5 horsepower: Class F.
   4. Power: 3 phase, 480 volts.

5. 1.15 service factor.
6. Type:
    a. Capable of continuously running with pump unit dry or unsubmerged at ambient temperature rating without damaging motor.
    b. Able to operate continuously without exceeding pumps service capacity when immersed in water up to 104 degrees Fahrenheit.
7. Cable:
    a. Minimum length sump depth to the VCP, plus 15 feet, armored, waterproof cable securely attached to motors with watertight fittings. Provide minimum number 16 AWG cord.
    b. Continuous power cable as indicated on the Drawings or suitable for modification to meet the conditions as indicated on the Drawings.

2.04 ACCESSORIES

A. Accessories:
1. Lifting chains or cables:
    a. Material: Type 316 stainless steel.
    b. Attached to balance point of pump; suitable for lifting pump from sump; long enough to extend from sump cover or grating.
2. Lifting hangars:
    a. Material: Type 316 stainless steel.
    b. Suitable to provide storage of chain or cable at top of sump.

2.05 CONTROLS

A. General:
1. Provide a vendor control panel at each installation for control of the pumps, except as indicated on the pump schedule.

B. Vendor control panel:
1. Provide when Scheduled.
2. Construction and components as specified in Section 13390 – Packed Control Systems.
3. Enclosure:
    a. As indicated in the pump schedule.
4. Electrical components:
    a. Main circuit breaker:
        1) As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
        2) Flange-mounted operator:
            a) Pad-lockable in the off position.
        3) Disconnects all power to the panel.
        4) Interlock with the panel door:
            a) Defeat mechanism.
    b. Motor starter for each pump:
        1) Motor circuit protector circuit breaker.
        2) Full voltage non-reversing magnetic starter.
        3) Thermal or electronic overloads.
    c. Control power transformer:
        1) Primary voltage: 230/460 VAC, 3 phase, 60 hertz.

2) Secondary voltages:
a) Control and status points to the facility SCADA system: 120 volt.
b) Additional voltages as required by the application.
3) Sized for all panel components plus 10 percent spare capacity.
4) Primary and secondary fuses.

5. Control components:
a. Terminal strips:
1) Provide terminal strips for landing all external wiring.
b. Relays, timers, and other components as required providing the specified functionality and remote monitoring connections.

6. Duplex operation:
a. Front Panel Controls:
1) HAND/OFF/AUTO switch.
2) START pushbutton for each pump.
3) STOP pushbutton for each pump.
4) LEAD-STANDBY selector switch which will permit operator selection of either Pump Number 1 or Pump Number 2 as the lead pump during automatic operation.
5) Momentary LOW-LEVEL OVERRIDE pushbutton.
6) Running pilot light for each pump.
7) Pump fault pilot light for each pump.
8) High-High-level alarm.
9) Alarm beacon:
a) Alarm silence pushbutton.
b. Remote monitoring and control:
1) Provide dry relay contact outputs for the following:
a) Pump Fault alarm: one for each pump.
b) Pump Run status: each pump.
c) High-High Level Alarm.
c. Operation:
1) Hand:
a) The pump shall run when the START pushbutton is pressed.
b) The pump shall stop when the STOP pushbutton is pressed.
c) The LOW-level switch shall stop the pump.
d) The LOW-level switch shall be over ridden by the momentary LOW-LEVEL OVERRIDE pushbutton.
2) Off: Pump shall stop operation:
a) Placing the hand switch in the OFF position shall reset all alarm conditions.
3) Auto: The pump shall operate automatically in response to level switch signals:
a) The lead pump shall start when the rising water level in the sump causes level switch HIGH-level switch to activate.
b) The lead pump shall stop when the falling water level in the sump causes level switch LOW-level switch to activate.
c) If the lead pump fault alarm is activated the standby pump shall replace the lead pump.
d) A high- high level shall cause the HIGH-HIGH-level switch to activate and activate the HIGH-HIGH-level alarm.

2.06 LEVEL SENSORS

A. Type: Ball float as specified in Section 17380 – Field Instrumentation and Sensing Devices.

B. Cable Length: The length of the cable shall be equal to sump depth to the VCP plus 5 feet.

2.07 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

B. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

PART 3 EXECUTION

3.01 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 1-day minimum.
      b. Functional Testing: 1 trip, 1-day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 1 session.
      b. Operation: 1 hours per session, 1 session.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing: As specified in Pump Schedule.

B. Functional testing: As specified in Pump Schedule.

3.02 PUMP SCHEDULE

A. Pump characteristics:

Tag Numbers	**FLTR-SUMPPUMP-01** **FLTR-SUMPPUMP-02**
General Characteristics	
Location	Filters
Service	Drain

Tag Numbers	FLTR-SUMPPUMP-01 FLTR-SUMPPUMP-02
Pump Type	Type 1
Rated Design Point:	
Flow, Gallons per Minute	100
Head, Feet	9.6
Other Conditions:	
Min. Shutoff Head, feet	20
Motor Characteristics:	
Minimum Motor Horsepower	0.5
Motor Speed, revolutions per minute	1,750
Vendor Control Panel:	
Required	Yes
Operation	Duplex
Enclosure Type	NEMA 4X Stainless Steel
Source Testing:	
Performance Test Level	1
Functional Testing:	
Performance Test Level	1

END OF SECTION

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SECTION 11312R

SINGLE-LOBE ROTARY PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Rotary lobe type positive displacement pump with driver, and features as specified and scheduled in this Section. Refer to related Specifications for additional requirements.

B. Tag numbers: As specified in Pump Schedule.

1.02 REFERENCES

A. American Gear Manufacturers Association (AGMA).

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):
1. A48 - Standard Specification for Gray Iron Castings.
2. A276 - Standard Specification for Stainless Steel Bars and Shapes.
3. A278 - Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C).
4. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
5. A470 - Standard Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts.
6. A516 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Temperature Service.
7. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.

D. Hydraulic Institute (HI):
1. 3.1-3.5 - Rotary Pumps for Nomenclature, Definitions, Application and Operation.
2. 3.6 - Rotary Pump Tests.
3. 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, Sound Measurement and Decontamination.

E. National Electrical Manufacturers Association (NEMA).

1.03 DEFINITIONS

A. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr) are as defined in HI 3.1-3.5, 3.6, and 9.1-9.5 and as modified in the Specifications.

B. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric. Average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SYSTEM DESCRIPTION

A. Components:
   1. Rotary lobe type positive displacement pumps with convoluted type quad lobe rotors, motors, seals, couplings, base plates, guards, supports, anchor bolts, taps, lifting eyes, stands, and other items as specified and as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. Performance tolerances shall be the same as the test tolerances specified in Section 15958 - Mechanical Equipment Testing.
      c. Pumps shall be suitable for installation as specified in this Section and as indicated on the Drawings.
   2. Motor characteristics: As specified in Pump Schedule.

C. Product requirements as specified in Section 01600 - Product Requirements and Section 15050 - Common Work Results for Mechanical Equipment.

1.05 SUBMITTALS

A. Submit as specified in City of Austin Section 01300 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Torsional analysis: When scheduled, submit as specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Vendor operation and maintenance manuals: As specified in City of Austin Section 01730 - Operation and Maintenance Manuals.

F. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.06 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pumps: One of the following, or equal:
   1. Vogelsang USA, LTD
   2. Boerger, LLC.
   3. Netzsch.

2.02 MATERIALS

A. General: Materials in the Pump Schedule shall be the type and grade as specified in this Section.

B. Cast iron: ASTM A48, Class 30 minimum.

C. Gray iron casting: ASTM A278, Class 30.

D. Buna-N: Synthetic rubber with a minimum Durometer hardness of 70 in accordance with ASTM D2240 test methods.

E. Steel: ASTM A283, Grade D or ASTM A516 Grade 70.

F. Stainless steel: ASTM A276, Type 316 stainless steel; nickel - chrome - boron coating as scheduled.

G. Carbon steel: ASTM A470.

H. All elastomers shall be Buna-N.

2.03 GENERAL PUMP CONSTRUCTION

A. Type: Industrial, heavy duty, positive displacement, rotary lobe type pumps meeting performance requirements and features as scheduled and as specified.

B. Service: Pumping units shall be designed to convey sludge. Normal solids concentrations will range from 0.8 to 3.0 percent. Other service requirements shall be as scheduled.

C. All equipment shall be designed and built for 24-hour continuous service at the rated design condition without overheating, without cavitation, and without excessive vibration or strain.

D. All working parts of the pumps and motors, such as bearings, wearing rings, shaft, sleeves, etc., shall be standard dimensions built to limit gauges or formed templates, such that parts will be interchangeable between like units and such that the Owner may obtain replacement and repair parts for those furnished in the original machines at any time in the future.

E. All lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards.

F. Pump shall be capable of temporarily running dry without damage and operate in either direction.

2.04 PUMP CASING

A. Materials:
   1. Pump casing: As scheduled.
   2. Pump top and bottom housing: As scheduled: minimum 750 Brinell hardness.
   3. Front and end covers: Same as pump casing.
   4. Wear plates: As specified.

B. Top and bottom pump housing: Top and bottom segments of the pump shall be adjustable based on wear up to 6 millimeters. The adjustment shall be accomplished by simply moving stainless steel shims from one hole to the next in the pump housing, allowing for the closing of tolerance around the rotors. This adjustment must be available a minimum of 2 times from factory tolerance.
   1. In lieu of providing adjustable top and bottom segments, manufacturer may provide radial wear plates on the casing walls that utilize the same philosophy as the front and rear wear plates.
   2. The radial wear plates shall be designed to allow the Owner to replace the worn component and bring the radial casing back to factory tolerance.

C. Front cover:
   1. The removable front cover shall be mounted to the pump with 4 individual bolts.
   2. The front cover shall permit removal of the rotors without disturbing piping, bearings, and mechanical seals.
   3. The front cover shall be machined to accept a reversible wear plate.

D. End cover:
   1. The removable end cover shall be flush with no recesses or dead pockets where solids can accumulate.
   2. The end cover shall be sealed with Buna-N o-ring and provide complete access to the pump chamber without disconnecting pipe work glands or bearings.

E. Wear plates: Wear plates shall be constructed of Hardox 500 material, or equal, with a minimum Brinell hardness of 550 and a finished, hardened, reversible surface of 700 Brinell.

F. Port connections: Provide ANSI Class 150 raised face flanges. Connections shall be suitable for field coating as specified in Section 09960 - High-Performance Coatings.

G. Dry-run Protection
   1. Each pump shall have a thermal probe attached to the pump housing to monitor lobe temperature. Probe shall not be in contact with pumped fluid.
   2. Probe shall initiate alarm at pump panel upon detection of high temperature.

2.05 PUMP ROTORS

A. Materials:
   1. Rotor core: As scheduled.
   2. Rotor (and/or rotor tip) coating: As scheduled.

B. Construction:
   1. The pump shall utilize 2 quad lobe rotors, which are driven through positive timing gears running in oil.
   2. Rotor cores shall be covered with a rotor coating as scheduled.
   3. The geometry of the rotor core shall be the same as that of the finished rotor.
   4. Rotor vane geometry shall be convoluted to provide pressure-pulse free operation.
   5. Designs with rotor vanes parallel to the shaft centerline will not be accepted.
   6. The convoluted rotor shall be specifically designed for pumping sludge containing organic solids, small inorganic particles, and grit.
   7. Rotors shall be positioned on the shaft by replaceable hardened key ways and secured to the shaft by internal/external expansion clamp sleeves and flush discs requiring no recesses in the end cover.

C. In lieu of providing solid rotors, rotors may be provided with replaceable tips. Rotor, rotor tip, and rotor coating material shall be as specified.

D. Stacking of lobes is not acceptable.

2.06 SHAFTS

A. Materials:
   1. Shaft: As scheduled.
   2. Shaft sleeve: As scheduled: ceramic coated.

B. Construction: Pump shafts shall be designed to provide sufficient stiffness to operate without distortion, damaging vibration, or excessive wear throughout the range of operation specified.

C. Sludge wetted rotor/shaft connections are not acceptable.

2.07 STUFFING BOXES

A. Construction:
   1. A blocking chamber located behind the mechanical seal and in front of the bearing housing lip seal shall be molded into the casting of the pump.
      a. This chamber shall be suitable for oil fill through the top and bottom of the pump.
      b. This chamber will have an external pressurized oil bottle mounted above the pump from the fill nipples to view the status of the mechanical seals.
   2. The external oil bottle will be located in view of the operator. Oil-quench shall provide lubrication and cooling of the seal, allow detection of seal failures, and provide a buffer zone to the sealed timing gear. Seal water flush systems are not acceptable.
      a. In lieu of providing an external pressurized oil bottle mounted above the pump, manufacturer may provide a plastic stopper on the chamber that is

vented to the atmosphere, which will allow fluid to escape as an indication of seal failure.

B. Shaft seal type: As scheduled.

C. Design of the pump shall allow removal and replacement of the seal via the front cover.
   1. Seal designs that open during rotor replacement are not acceptable.

D. Oil drain gearbox and intermediate chamber shall be easily accessible.
   1. Oil drain under the pump is not acceptable.

2.08 GEAR REDUCERS

A. Gear reducers and couplings shall meet the requirements as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Provide NEMA C face connection between motor and gearbox.

C. Provide helical reduction gears, rated for AGMA Class II service with a 1.5 service factor.

D. Provide oil bath lubrication.

2.09 SUPPORTS, PEDESTALS, AND BASEPLATES

A. Materials: Same as pump casing or ASTM A283 steel, hot-dip galvanized after fabrication and coated as specified in Section 09960 - High-Performance Coatings.

B. Pump, driver, and intermediate bearing support strength: Able to withstand minimum 1.5 times maximum imposed operating loads or imposed seismic loads, whichever is greater.

C. Configuration:
   1. Support pump, gear reducers, and motor on a common structural steel baseplate.
   2. Pumping unit shall be furnished in a piggyback arrangement, belt driven with motor overtop of pump.
   3. Belt drive shall be as specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Anchor bolts: Designed by the pump manufacturer:
   1. 3/4-inch minimum diameter.
   2. As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.10 EQUIPMENT GUARDS

A. Provide safety guards as specified in Section 15050 - Common Work Results for Mechanical Equipment.

2.11 DRIVERS

A. Horsepower:
   1. As scheduled.
   2. Listed driver horsepower is the minimum to be supplied.
      a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.
      b. When scheduled driver is a motor, increase motor horsepower if required to prevent operation in the service factor.
      c. Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.

B. Motors: Provide motors as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower and as specified in this Section.
   1. Revolutions per minute: As scheduled.
   2. Enclosure: As scheduled.
   3. Electrical characteristics: As scheduled.
   4. Efficiency, service factor, insulation, and other motor characteristics: As specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.
   5. Motor accessories: As specified in Section 16222 - Low Voltage Motors up to 500 Horsepower and in this Section.
   6. Coordinate motors with the variable frequency drive manufacturer to ensure compatibility between the motor and variable frequency drive.

C. Other drivers: As scheduled and as specified in sections listed in the Schedule.

D. Non-reverse ratchets: When scheduled, provide driver with non-reverse ratchets or pin mechanism to prevent reverse rotation of the pump and driver in the event of discharge valve failure.

2.12 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: Deliver the following for each type or size of pump:
   1. 1 set of mechanical seals.
   2. 1 set of o-rings.
   3. 1 set of wear plates (front, back, and radial).

B. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

PART 3 EXECUTION

3.01 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Source Testing.
      b. Manufacturer’s Certificate of Installation and Functionality Compliance.

2. Manufacturer's Representative onsite requirements:
   a. Installation: 1 trip, 3-day minimum.
   b. Functional Testing: 2 trips, 1-day minimum each.
3. Training:
   a. Maintenance: 2 hours per session, 1 sessions.
   b. Operation: 1 hours per session, 1 sessions.
4. Process operational period:
   a. As required by Owner or Contractor.

C. Source testing: As specified in Pump Schedule.

D. Functional testing: As specified in Pump Schedule.

3.02 PUMP SCHEDULE

Tag Numbers	**SHF-SLUDGEPUMP-01 SHF-SLUDGEPUMP-02**
General Characteristics:	
Service	Thickening Sludge Pumps
Quantity	2
First Named Manufacturer's Model Number	VX136-140Q
Maximum Noise, dBA at 3 feet	85
Minimum Pump Displacement (gal/100 rev)	95
Torsional Analysis	Not Required
Minimum Pumped Fluid degrees Fahrenheit	60
Normal Pumped Fluid degrees Fahrenheit	80
Maximum Pumped Fluid degrees Fahrenheit	100
Pump Characteristics:	
Impeller Type	Positive Displacement, Rotary Lobe
Shaft Seal Type	Double Mechanical
Coupling Type	Spacer
Speed Control	Variable Frequency Drive
Maximum Pump rpm	350
Minimum Pump rpm	110
Suction Flange Diameter, Inches	6
Discharge Flange Diameter, Inches	6
Rated Design Point (at Maximum Revolutions per Minute):	
Flow, Gallons per Minute	400
Head, Feet	17
Minimum Operating Range:	
Flow, Gallons per Minute	130
Head Range, Feet	10 to 12

Tag Numbers	SHF-SLUDGEPUMP-01 SHF-SLUDGEPUMP-02
Other Conditions:	
Minimum NPSHa at Every Specified Flow, Feet	31
Pump Materials:	
Casing	Gray Cast Iron
Top and Bottom Pump Housing	Gray Cast Iron
Rotor Core	Gray Cast Iron
Rotor Coating (including rotor tip coating)	Buna-N
Shaft	Carbon Steel
Shaft Sleeve	316 Stainless Steel, Ceramic Coated
Nuts and Bolts	316 Stainless Steel
Driver Characteristics:	
Driver Type	Motor
Drive Arrangement	Gear Reducer
Minimum Driver Horsepower	10
Maximum Driver rpm	1,750
Motor Characteristics (when motor is driver type):	
Inverter Duty Rated	Yes
Motor Voltage/Phases/Hertz	460/3/60
Enclosure Type	TEFC
Source Testing:	
Test Witnessing	Not Witnessed
Performance Test Level	1
Vibration Test Level	1
Noise Test Level	None
Functional Testing:	
Performance Test Level	1
Vibration Test Level	1
Noise Test Level	1

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SECTION 11312X

HORIZONTAL PROPELLER PUMP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: mixed liquor return (MLR) submersible horizontal axial flow pumps and appurtenances in the aeration basins.

1.02 REFERENCES

A. American Bearing Manufacturers' Association (ABMA):
   1. 9 – Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 – Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 – Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250.
   2. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24.

B. ASTM International (ASTM):
   3. A 48 – Standard Specification for Gray Iron Castings.
   4. A 108 – Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   5. A 276 – Standard Specification for Stainless Steel Bars and Shapes.
   6. A 283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   7. A 532 – Standard Specification for Abrasion-Resistant Cast Irons.
   8. A 536 – Standard Specification for Ductile Iron Castings.
   9. A 576 – Standard Specification for Steel Bars, Carbon, Hot Wrought, Special Quality.
   10. A 582 – Standard Specification for Free-Machining Stainless Steel Bars.
   11. A 743 – Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   12. B 505 – Standard Specification for Copper Alloy Continuous Castings.
   13. B 584 – Standard Specification for Copper Alloy Sand Castings for General Applications.
   14. B 763 – Standard Specification for Seamless Copper Tube in Coils.
   15. E 10 – Standard Test Method for Brinell Hardness of Metallic Materials.
   16. F 593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   17. F 594 – Standard Specification for Stainless Steel Nuts.

C. Hydraulic Institute (HI):
   18. 1.1-1.2 – Centrifugal Pumps for Nomenclature and Definitions.
   19. 1.3 – Rotodynamic (Centrifugal) Pumps for Design and Application.
   20. 9.1-9.5 – Pumps – General Pump Standards for Types, Definitions, Application, and Sound Measurements and Decontamination.
   21. 14.6 – Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

D. Insulated Cable Engineer's Association (ICEA).

E. National Electrical Code (NEC).

F. National Electrical Manufacturers Association (NEMA).

G. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. Flow, head, efficiency, and motor horsepower specified in this Section are minimums unless stated otherwise.

B. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 1.6, and 9.1-9.5 and as modified in this Section.

C. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SYSTEM DESCRIPTION

H. General:
   1. Propeller pumps shall be submersible with the motor close-coupled, directly connected to the propeller. Gearbox designs shall not be acceptable. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in sanitary sewage applications.
   2. Propeller pumps shall be designed for operation under four (4) feet minimum of complete submersion.
   3. Each propeller pump shall be specially designed and manufactured for the service intended.

I. Submersible pumps and components: Submersible pump, motor driver, electrical cable, lifting eyes, lifting cable or chain and guide rails, guide rail supports, self-aligning discharge connection, and other items specified in the Pump Schedule as required for complete operational units.

J. Pump Operating Requirements:
   1. Continuously rising pump curve with no point of zero slope or slope reversal from shut-off head to the specified minimum head.
   2. Stable and free from excessive vibration, motor overloading, and cavitation from shutoff head through the specified operating range.
   3. Performance tolerances shall be the same as the test tolerances specified in Section 15958 – Mechanical Equipment Testing.

K. Pumps shall be suitable for pumping fluid as scheduled.

L. Pumps shall be suitable for continuous operation.

M. Design requirements:
    4. Pump performance characteristics:
        a. As specified in the Pump Schedule.
        b. Performance tolerances shall be the same as the test tolerances specified in Section 15958 – Mechanical Equipment Testing.
    5. Motor characteristics: As specified in the Pump Schedule.

1.05 SYSTEM OPERATION

A. System operation as specified in Section 17101 – Specific Control Strategies.

1.06 SUBMITTALS

A. Submit as specified in Section 15050 – Common Work Results for Mechanical Equipment.

B. Product Data and Shop Drawings for Each Pump to Include:
    1. Complete shop and installation drawings.
    2. Literature and drawings describing the equipment in sufficient details, including parts list, dimensions, materials, and details of construction and installation.
    3. Electrical schematic and wiring diagrams and other data as required for the complete system.
    4. Certified dimensional data for components, including foundation and anchor bolts and details.
    5. Equipment Data:
        a. Pump information (each pump):
            1) MANUFACTURER.
            2) Model.
            3) Impeller type, and size.
            4) Weight of pump and motor.
        b. Pump performance data (each pump):
            1) Pump speed.
            2) Pump curve.
            3) Power versus flow curve.
            4) Hydraulic efficiency curves.
        c. Motor data.
    6. Descriptive brochures of each item of auxiliary equipment.
    7. Calculation of rail wall thickness.

C. Torsional Analysis: Submit as specified in Section 15050 – Common Work Results for Mechanical Equipment when scheduled.

D. Furnish motor submittals as specified in Section 16222 – Electric Motors, Induction, 600V and Below.

E. Bearing Life Calculations: Submit as specified in Section 15050 – Common Work Results for Mechanical Equipment.

F. MANUFACTURER’s qualifications to substantiate requirements as specified in this Section.

G. Operation and Maintenance Manuals as specified in Section 01730 - Operations and Maintenance Manuals.

1.07 QUALITY ASSURANCE

A. As specified in Section 15050 – Common Work Results for Mechanical Equipment.

B. Package Systems: Each pump shall be provided as a complete package by one MANUFACTURER or supplier, including pumps, motors, wall plate, guide rails, hoists, monitors, marine grade cables, and specified appurtenances.

C. Require pump MANUFACTURER to furnish and coordinate pump, motor, variable frequency drive, and pump components as specified and scheduled and to provide written installation and check out requirements.

D. MANUFACTURER qualifications: MANUFACTURER of pumps similar to specified pumps as evidenced by references to minimum 5 installations currently having operated the same model and drive configuration pump as proposed, operating under similar conditions of head, flow, and speed for minimum 5 years.

E. Pump Test: The pump MANUFACTURER shall perform the following inspections and tests on each pump before shipment from the factory:
   1. Propeller(s), motor rating(s), and electrical connection(s) were checked for compliance to the purchase order.
   2. All pumps are vacuum tested to establish sealing integrity. All pumps are momentarily energized to determine correct rotation and current draw (prior to immersion).
   3. All pumps are run dry and/or immersed to determine correct shaft rotation, and power consumption.
   4. After immersion test(s), all pumps are inspected for lubricant seepage and/or water infiltration, insulation defect(s), and resistance (ohms).

F. Inspections and tests performed shall confirm the pump(s) listed have met all established quality assurance standards set for similar materials. All pumps shall be warranted against defects in design, workmanship, and material (with validation being the warranty card(s) shipped with the product(s)).

G. A written report stating the foregoing steps have been done and may be required with each pump at the time of shipment (upon prior notice to the fabrication of the pumps).

H. Provide pumps specified in this Section from same MANUFACTURER.

1.08 DELIVERY, STORAGE, AND HANDLING

N. As specified in Section 15050 – Common Work Results for Mechanical Equipment.

1.09 PROJECT CONDITIONS

O. Environmental requirements: As specified in Section 01610 – Project Design Criteria.

1.10 WARRANTY

A. As specified in Section 15050 – Common Work Results for Mechanical Equipment.

1.11 MAINTENANCE

A. Special tools required for normal operation and maintenance of the equipment shall be furnished with the equipment by the Manufacturer.

B. Spare parts: Deliver the following as specified in Section 01610 - Product Requirements:
   1. Cable seals: 1 set of seals, gaskets, and O-rings.
   2. Seal packing material: 1 set of each type supplied.
   3. Mechanical seal: 1 complete seal assembly for each type supplied.
   4. Pump bearings: 1 set of radial and one set of thrust bearings for each pump size supplied.
   5. Pump impeller: 1 replacement impeller for each size supplied.
   6. Replacement liner: 1 replacement liner for each size specified (as applicable).

C. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pump: One of the following or equal:
   1. Wilo-EMU, RZP 20.
   2. Xylem-Flygt, PP Series.
   3. Landia, AXD model.

B. The propeller pump specified herein shall be the design and fabrication of a single MANUFACTURER that shall have sole source responsibility for said equipment.

2.02 DESIGN

A. Furnish two submersible horizontal propeller pumps for each aeration basin that will operate in a duty/duty configuration.

B. Design Conditions: see Pump Schedule.

C. All motor cables shall be neoprene- or CPE-jacketed. Each unit shall be fitted with 30 feet (minimum) of lifting cable of adequate strength to permit raising and lowering the pump.

2.03 MATERIALS

A. General: When materials are referenced in this Section or on the pump schedule, the compositions shall be the UNS Alloys, Types, or Grades unless specified or scheduled otherwise.

B. Cast iron: ASTM A 48, Class 35 B minimum.

C. Nickel cast iron: ASTM A 48, Class 35 minimum with 3 percent nickel added.

D. Steel: ASTM A 108, Grade or UNS Alloy as specified or scheduled.

E. Stainless steel: ASTM A 276 or ASTM A 582, Type or UNS Alloy as specified or scheduled.

F. Bronze: ASTM B 505 or ASTM B 584, UNS Alloy C83600.

G. Zincless bronze: ASTM B 505 or ASTM B 584, Leaded Tin Bronze, UNS Alloy C92700.

H. Aluminum bronze: ASTM B 148, ASTM B 505 or ASTM B 584, UNS Alloy C95200.

I. Fasteners: Stainless steel, ASTM F 593 or ASTM F 594, type or grade as specified.

2.04 PUMP COMPONENTS

A. Pump Design:
   1. The pumps shall be capable of handling raw, screened wastewater. The pumps shall be able to be raised and lowered, and shall be easily removed for inspection or service without the need for bolts, nuts or other fastenings to be disconnected and without the need for personnel to enter the aeration basin.
   2. The Manufacturer shall provide guide rail brackets and other items required for a guide rail type removal system.
   3. The pump, with its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet.
   4. A stainless steel nameplate giving the Manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to each propeller pump.
   5. Provide propeller pump with lifting lugs or eyebolts.

B. Pump Construction:
   1. Each pump shall be of the integral design, close coupled, submersible type. All components of the pump, including motor, shall be capable of continuous underwater operation. In addition, all components of the pump shall be capable of continuous operation completely unsubmerged, for 2 hours.
   2. The pump shall be of Type 316 stainless steel construction or epoxy coated cast iron. The lubricant housing cover plate shall be of corrosion resistant plastic. All exposed nuts and bolts shall be of Type 316 stainless steel.

C. Elastomers: All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber or Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

D. Propeller: The propeller shall be of Type 316 stainless steel, dynamically balanced, nonclogging backward-curved design. Each blade shall be laser cut and welded to the hub and tested to ensure that the propeller is properly balanced. The propeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications. The propeller shall have three blades. The propeller shaft shall be of Type 420 stainless steel or Type 316 stainless steel.

E. Bearings: All bearings shall have a minimum B-10 rated life of 100,000 hours. The outboard propeller bearing shall be an angular contact bearing. The motor shaft end shall be supported by two bearings. A roller bearing shall take up the radial loads, while an angular contact bearing shall take up the axial loads.

F. Bearing Housing: A536 ductile iron, and machined with piloted bearing fits for concentricity of all components. Piloted motor mount shall firmly align motor on top of bearing housing.

G. Lubricant Housing: The lubricant housing shall contain two compartments consisting of an inner and an outer Section with four ports to connect and facilitate lubricant flow. In the event that the mixed media bypasses the outer seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of the simple process of gravity.

H. Mechanical Seals:
   1. Each pump shall be provided with two sets of lapped and face type mechanical seals running in an oil housing for cooling and lubrication. The mechanical seals shall contain both stationary and positively driven rotary tungsten carbide face rings, unless otherwise specified. In order to avoid seal failure from sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be contained in the oil housing. All seal faces must be solid material capable of being relapped.
   2. The seals shall require neither maintenance nor adjustment, but shall be easy to check and replace. Shaft seals without positively driven rotating members shall not be considered acceptable or equal.
   3. The oil housing shall contain two compartments consisting of an inner and outer Section with four ports to connect and facilitate oil flow.

I. Shroud Assembly: The pump assembly shall incorporate a bell shaped inlet shroud, 360 degrees around the propeller. Nuts on the shroud to the pumps shall be bolt pinned so the nuts do not back off.

J. Jet ring assembly:
   1. The propeller pump shall incorporate a jet ring a full 360 degrees around the propeller. The jet ring shall be fabricated from 316 stainless steel.
   2. A maximum clearance of 1.5 inches shall be maintained between the propeller tip and the shroud in order to maintain hydraulic efficiency and minimize power consumption.

2.05 MOTORS AND POWER CABLES

A. Motor:
   1. General: The multi-pole motor shall either be directly connected to the propeller or through a gearbox that locates the motor shaft in line with the propeller shaft.
   2. Horsepower:
      a. As scheduled in the Pump Schedule.
         1) Listed motor horsepower is the minimum to be supplied. Increase motor horsepower if required to prevent motor overload while operating at any point on the supplied pump operating head-flow

curve, including runout. However, electrical equipment are sized for scheduled motor horsepower.
2) Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.

3. Revolutions per minute: As scheduled in the Pump Schedule.
4. Enclosure: As scheduled in the Pump Schedule.
5. Electrical characteristics: As scheduled in the Pump Schedule.

B. Motor Construction
1. Squirrel cage induction motor, shell design.
2. The rotor bars and short circuit rings shall be made of aluminum.
3. If explosion proof motor is scheduled, provide motor that is UL or FM listed for NEC Class 1, Division 1, Groups C and D service, whether submerged or unsubmerged.
4. NEMA design type: B.
5. Motor insulation, either one:
   b. Class F, moisture resistant, rated for 155 degrees Celsius.
   c. Class H, moisture resistant, rated for 185 degrees Celsius.
6. The motor shall be designed for continuous duty handling pumped media of 40 degrees Celsius and capable of a minimum of 15 evenly spaced starts per hour.
7. The motor shall be capable of continuous operation under load with the motor submerged, partially submerged, or exposed, without derating the motor.
8. Motor cooling system:
   d. Design to provide adequate cooling:
      1) With motor submerged.
9. Motor sealing: Design motor case and seals to withstand 65 feet of submergence.

C. Power cables:
1. Submersible to same water depth as motor casing.
2. Type: oil resistant chloroprene rubber jacketed.
3. Insulation rated for 90 degrees Celsius.
4. Non-wicking fillers.
5. Length: Sufficient to connect to surface junction box (without the need of splices) as indicated on the Drawings or 30 feet, whichever is greater.
6. Sized to conform to NEC, ICEA, and CSA specifications.
7. Provide stainless steel cable and stainless steel wire braid sleeve to support power cable from underside of wet well roof slab or access frame.
8. Control conductors for over-temperature and moisture-detection sensors shall be integral with the motor power cable.

D. Cable Entry Seal and Junction Chamber:
1. Cable entry seal design shall not require specific torque requirements to insure a watertight and submersible seal.
2. The cable entry housing shall be an integral part of the back plate.
3. The cable entry seal shall provide strain relief for the cable.
4. The cable entry shall be comprised of dual cylindrical elastomer grommets, each flanked by stainless steel washers and ferrule designed with close tolerance fit to ensure a redundant system in the event of a cable entry seal failure.

5. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it.
6. The junction chamber and motor compartment shall be separated by a terminal board, which shall protect the motor interior from foreign material gaining access into the propeller pump top.
7. The terminal compressed type post and a terminal board O-ring shall render the motor compartment leak proof. All other sealing systems shall be considered unacceptable.
8. Provide a moisture detection sensor in the cable junction chamber. If leakage is detected, the sensor shall activate an alarm and shut down the pump/motor.

E. Control/Protection Module:
1. Each pump shall be supplied with its own self-contained control/protection module to provide for the direct connection to all internal pump monitoring devices, including:
e. Thermal protection: Provide automatic reset motor stator temperature detectors, 1 switch in each phase winding. If any detector is activated, the sensor shall activate an alarm and shut down the motor. The thermal detectors shall activate when the stator temperature exceeds 125 degrees Celsius.
f. Moisture detection: One of the following:
1) Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor. The sensor shall have an explosion proof rating.
2) Provide a small float to detect the presence of water in the stator chamber.
2. The module shall signal an alarm condition if any of the internal monitoring devices is activated.

F. Pump Protection:
1. Pump protection system will be provided to protect pumps against the following:
g. Overload.
h. Overtemperature.
i. Moisture detected.

2.06 GUIDE RAILS AND LIFTING DEVICES

A. General: Pump MANUFACTURER shall provide a permanently installed guide rail assembly that allows for pump installation, operation, and retrieval without the need to enter the aeration basin.

B. Materials:
1. Guide rails, lifting cable or chain and wall supports: Type 316 stainless steel.
2. Anchor bolts: As specified in Section 05190.
3. Provide Type 316 stainless steel safety lift cable for each propeller pump. Cable shall have a minimum diameter of 1/4 inch.

C. Guide Rail and Pump Mounting:
1. Type: Dual pipe or dual rail able to accurately guide the pump to mate with the pump support plate.

2. Strength: Withstand the greater of a minimum of 1.5 times the maximum imposed operating loads or seismic loads in accordance with building code as specified in Section 01410 seismic loads.
3. Intermediate supports: Factory-welded mounting brackets at the top, bottom and intermediate levels as needed to provide support at a maximum of 10-foot intervals; less as required to provide specified support.
4. A fabricated support frame shall support the weight of the pump at its horizontal center of gravity. Cantilevered designs, with the pump suspended on its own motor housing, will not be considered equal to a support frame design.
5. The guide rails and brackets must be capable of handling all thrust created by the propeller pump.

D. Lifting Device:
1. A hoist system shall be used for lifting and lowering of the pump on the guide rail during installation and maintenance.
2. The lifting device shall be supplied by the selected MLR pump manufacturer. Pump manufacturer shall be responsible for coordination and selection of lifting device to ensure proper placement and removal of pump. Refer to Drawings for dimensions and layout.
3. Type: Chain or cable attached to lifting eye on the pump casing.
4. The hoist system shall include a manual brake winch, and shall be adequately rated to lift the pump and support arm off the mast and directly onto the adjacent deck surface.
5. Length: Able to lower pump from top of aeration deck to operating position as indicated on the Drawings plus 5 additional feet of length.
6. The system shall be capable of 360 degree-rotation. All crane and receiving boxes shall be constructed of Type 316 stainless steel. The sleeves and the bearings in the receiving box shall be constructed of Nylon (PA).
7. Each aeration basin contains two pumps side by side. One lifting device shall be of adaquate length to accommodate lifting and lowering of both pumps individually. A total of four lifting devices are proposed with proper mounted bases as seen in the Drawings.
8. If handrail is fitted to the deck, removable sections shall be provided such that the pump does not need to be lifted over the handrail.
9. A 316 stainless steel lifting cable, permanently attached to each pump, shall be provided in sufficient length for attachment of the upper end to the winch cable reel when the davit assembly is installed.
10. Retainer: Provide Type 316 stainless steel locking hook or clasp at top of aeration basin top of concrete (TOC) to securely retain the upper end of the lifting chain or cable during pump operation.
11. Lifting device shall be sized for combined weight of pump and motor.

2.07 FINISHES

A. Prepare surfaces and apply protective finishes as specified in Section 09960 – High-Performance Coatings.

2.08 SOURCE QUALITY CONTROL

A. Witnessing: Source or factory testing shall be witnessed by the Engineer or Owner when scheduled; provide advanced notice of source testing as specified in Section 15958 – Mechanical Equipment Testing.

B. Equipment performance test: Test level as scheduled; test as specified in Section 15958 – Mechanical Equipment Testing.

C. Vibration test: Test level as scheduled; test as specified in Section 15958 – Mechanical Equipment Testing.

D. Noise test: Test level as scheduled; test as specified in Section 15958 – Mechanical Equipment Testing.

E. Hydrostatic pressure tests: As specified for components in this Section.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with Manufacturer's instructions and as specified in Sections 15050 – Common Work Results for Mechanical Equipment and 15958 – Mechanical Equipment Testing.

B. A factory trained representative shall be provided for installation supervision, startup and test services, and operation and maintenance personnel training services.

C. The serviceman shall make three (3) visits to the site.
   1. The first visit (8 hours) shall be for assistance in the installation of equipment.
   2. The second visit (8 hours) shall be for checking the completed installation and start-up of the system.
   3. The third visit (8 hours) shall be for Instruction of Operations and Maintenance Personnel.

3.02 FIELD QUALITY CONTROL

A. Witnessing: All field-testing shall be witnessed by the Engineer; provide advanced notice of field-testing as specified in Section 15958 – Mechanical Equipment Testing.

B. Inspection and checkout: As specified in Sections 15050 – Common Work Results for Mechanical Equipment and 15958 – Mechanical Equipment Testing.

C. Equipment performance test: Test level as scheduled; test as specified in Section 15958 – Mechanical Equipment Testing.

D. Vibration test: Test level as scheduled; test as specified in Section 15958 – Mechanical Equipment Testing.

E. Noise test: Test level as scheduled; test as specified in Section 15958 – Mechanical Equipment Testing.

F. Driver and motor tests: Test as specified in scheduled section.

G. Operational testing: As specified in Section 01756 - Commissioning and Start-up.

3.03 MANUFACTURER'S FIELD SERVICES

A. Require MANUFACTURER to inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up as specified in this Section and in Sections 15050 – Common Work Results for Mechanical Equipment and 15958 – Mechanical Equipment Testing.

B. Training: As specified in Section 01756 - Commissioning and Start-up.

3.04 PUMP SCHEDULE

Tag Numbers	**AB-RECYCLEPUMP-01 AB-RECYCLEPUMP-02 AB-RECYCLEPUMP-03 AB-RECYCLEPUMP-04 AB-RECYCLEPUMP-05 AB-RECYCLEPUMP-06 AB-RECYCLEPUMP-07 AB-RECYCLEPUMP-08**
General Characteristics:	
Service	Internal Mixed Liquor Recycle
Design Mixed Liquor Suspended Solids Concentration, mg/L	1,500 – 3,500
Minimum Clean Water Pumping Capacity, gpm	489
Maximum Propeller Speed, RPM	1670
Minimum Propeller Speed, RPM	450
Minimum Propeller Diameter, inches	7.5
Maximum Propeller Blade Angle, degrees	9
Quantity	4
First Named Manufacturer's Model Number	RZP 20
Arrangement	Wet Pit
Maximum Noise, dBA at 3 feet	85
Torsional Analysis	Not Required
Minimum Pumped Fluid degrees Fahrenheit	50
Normal Pumped Fluid Degrees Fahrenheit	80
Maximum Pumped Fluid Degrees Fahrenheit	100

Tag Numbers	**AB-RECYCLEPUMP-01** **AB-RECYCLEPUMP-02** **AB-RECYCLEPUMP-03** **AB-RECYCLEPUMP-04** **AB-RECYCLEPUMP-05** **AB-RECYCLEPUMP-06** **AB-RECYCLEPUMP-07** **AB-RECYCLEPUMP-08**
Pump Characteristics:	
Pass Minimum Sphere Size, inches	2.75
Bearing Lubrication	Oil
Shaft Seal Type	Double Mechanical
Coupling Type	Direct
Rated Design Point:	
Flow, Gallons per Minute	586
Head, Feet	2.3
Minimum Efficiency, Percent	51
Required Condition 2:	
Flow, Gallons per Minute	400
Head Range, Feet	2.6 to 2.8
Minimum Efficiency, Percent	40
Required Condition 3:	
Flow, Gallons per Minute	900
Head Range, Feet	1.6 to 1.8
Minimum Efficiency, Percent	62
Other Conditions:	
Shut Off Head, Feet	4.2
Minimum Suction Static Head, Feet	16.7
Maximum Suction Static Head, Feet	16.9
Pump Materials:	
Pump Casing	A48 CL35B
Suction Liner	Hi-Chrome Cast Iron
Propeller	316 Stainless
Propeller Shaft Key	420 or 316 Stainless
Shaft	Steel, ASTM A 576
Driver Characteristics:	
Driver Type	Constant Speed

Tag Numbers	**AB-RECYCLEPUMP-01** **AB-RECYCLEPUMP-02** **AB-RECYCLEPUMP-03** **AB-RECYCLEPUMP-04** **AB-RECYCLEPUMP-05** **AB-RECYCLEPUMP-06** **AB-RECYCLEPUMP-07** **AB-RECYCLEPUMP-08**
Drive Arrangement	Direct
~~Minimum~~ Maximum Driver Horsepower [AD5]	5
Maximum Driver Speed, rpm	1670
Motor Characteristics (when motor is driver type):	
Inverter Duty Rated	No
Motor Voltage/Phases/Hertz	460/3/60
Enclosure Type	Submersible
Motor Specification Section	16222 – Low Voltage Motors up to 500 Horsepower
Service Factor	1.15
Voltage/Phases/Hertz	460/3/60
Source Quality Control Testing:	
Test Witnessing	Not Witnessed
Performance Test Level	2
Vibration Test Level	1
Noise Test Level	None
Field Quality Control Testing:	
Performance Test Level	2
Vibration Test Level	None
Noise Test Level	None

END OF SECTION

[AD5] Addendum No. 5

SECTION 11313

MAGNETIC COUPLING VARIABLE SPEED CONTROL SYSTEM FOR RETURN ACTIVATED SLUDGE PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. The CONTRACTOR shall provide five (5) magnetic coupling variable speed drive units with accessories and controls, complete and operable, in accordance with the Contract Documents as specified herein and as shown on PLANs.

B. Electric motors shall be furnished as part of the work of this Section and shall conform to all applicable portions of Specification Section 16222, “Electric Motors, Induction, 600 Volts and Below”.

1.02 RELATED WORK

A. PLANS show general arrangement, location, and basic dimensions.

B. Horizontal, non-clog sewage pumps for Return Activated Sludge shall be furnished as part of Specification Section 11312F, ‘Sewage Pumps, Self-Priming, Volute-Mounted”, and shall conform to all applicable portions of work of this Section.

C. Related work as called for on PLANS or specified in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)
   1. ASTM A48 – Standard Specifications for Gray Iron Castings.

B. American National Standards Institute (ANSI)

C. Occupational Safety and Health Administration (OSHA)

D. Anti-Friction Bearing Manufacturers Association (AFBMA)

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SUBMITTALS

A. Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Specification Section 01300, “Submittals”. All submittals shall be marked with the appropriate equipment tag numbers. Submittals shall include at least the following:
   1. Certified shop and erection drawings showing all important details of construction and dimensions
   2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. Data on the characteristics and performance of the magnetic couplings.
4. The total weight of the equipment including weight of the single largest item.
5. A complete total bill of materials for all equipment.
6. A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item. Include gaskets, mechanical seals, etc. on the list. List bearings by the generic bearing model numbers only.
7. All information required by Specification Section 01730, "Operation and Maintenance Data".
8. A statement indicating bearing life.
9. Noise data as specified in Specification Section 01730, "Operation and Maintenance Data".
10. Complete description of surface preparation and shop prime painting.
11. Provide nameplate data and arrangement for Owner's Representative approval.
12. Copies of an operating and maintenance manual for the magnetic couplings shall be furnished to the Owner's Representative as provided for in Specification Section 01730, "Operation and Maintenance Data". The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.05 QUALITY ASSURANCE

A. System Coordination:
   1. CONTRACTOR retains overall responsibility to properly install, adjust, test, and place in operation the Pump Units, including motor and adjustable speed drive.
   2. All adjustable speed drives for the service provided under this Specification shall be the products of a single manufacturer. All motors for each service provided under this specification shall be the product of a single manufacturer. The pump manufacturer/supplier shall furnish the pumps, motors, and adjustable speed drive as a complete and integral package to insure proper coordination, compatibility, and operation of the system.
   3. Coordinate start-up with pump manufacturer, motor manufacturer, and drive manufacturer.

B. Manufacturer's Qualifications
   1. The magnetic clutch specified herein are intended to be standard equipment as defined by this Section. The couplings furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings. All equipment shall be furnished by a single manufacturer.
   2. The CONTRACTOR shall provide evidence to the ENGINEER that the manufacturer has a minimum of five (5) years of experience, within the last ten (10) years, in the design, manufacture, and supervision of installation of equipment of the type and size specified (or larger) under this Specification.
   3. The CONTRACTOR shall provide evidence to the ENGINEER that equipment which was designed and manufactured by the manufacturer, and which is similar to the equipment required under this Specification, has been in continuous and successful operation in at least five (5) separate facilities for the past five (5) years.

C. Manufacturer's representative

1. Furnish services and training required in this Specification Section.
2. The CONTRACTOR shall provide the services of a qualified manufacturer's service technician to:
   a. Assist in the installation of the equipment.
   b. Check the installation before the equipment is placed into operation.
   c. Assist in the performance of field tests.
   d. Assist in start-up of equipment.
   e. Train the plant operations and maintenance staff in the care, operation and maintenance of equipment.
3. The CONTRACTOR shall provide the services of the manufacturer's service technician at such times and for such duration of time as are needed to perform the tasks required of the representative as specified in Article 1.05.C.2 above. At a minimum, the services of the manufacturer's technician shall be provided as indicated herein below and any additional time required shall be provided at no additional cost to the OWNER. The number of visits and person-days per visit indicated below shall be understood as referring to the total required services for the lot of equipment provided under this Specification. However, the CONTRACTOR is advised that the number of visits and person-days per visit indicated below do not include (and are to be understood as being in addition to) the motor manufacturer's technician services.
   a. Installation: 1 visits of 1 person-days per visit
   b. Field testing: 1 visits of 1 person-days per visit
   c. Start-up: 1 visits of 1 person-days per visit
   d. Training: 1 visits of 1 person-days per visit
4. The CONTRACTOR shall coordinate the manufacturer's representative services such that technicians from the pump, adjustable speed drive, and motor manufacturer are present simultaneously at the project site during field testing and startup of the pumps.
5. The ENGINEER reserves the right to require that any unused person-days from any visit be applied to any other specific visit.
6. Person-days shall be understood only as days spent on-site (not in transit).
7. Unless otherwise authorized by the ENGINEER, the manufacturer's technician shall be a direct employee of the equipment manufacturer or a factory trained technician, with at least five (5) years of experience in the installation, testing and start-up of equipment of the type provided under this Specification. Provide resume of the proposed manufacturer's technician for ENGINEER approval before commencing of work. The manufacturer's sales and marketing personnel will not be accepted as manufacturer's technicians.
8. Reports: The CONTRACTOR shall submit a report from the manufacturer for each visit to the Site of the manufacturer's technician. The report shall provide complete information regarding the visit, including, but not limited to, dates, times, subject equipment, tasks performed, persons contacted, problems corrected, test results, training provided, and other pertinent information.
9. In addition to the above, the CONTRACTOR shall provide the services of person(s) authorized by the manufacturer to witness the unloading at the Site and, if stored, placing into storage the equipment provided under this Specification, and to ascertain the condition of said equipment. Manufacturers' sales and marketing personnel may be accepted as authorized person(s) to perform these specific tasks. The CONTRACTOR shall submit to the ENGINEER a report, completed by the authorized person(s) and certified

by the equipment manufacturer, documenting the findings of the authorized person(s).

1.06 DELIVERY, STORAGE AND HANDLING

A. Manufacturer shall carefully prepare the drive for shipment to minimize the likelihood of damage during shipment. Equipment shall be properly supported and securely attached to skids. Openings shall be covered in a manner to protect both the opening and interior.

B. Deliver, unload, and store products on site in a manner that prevents damage. Use special care to prevent damage from temperature and condensation.

1.07 SPARE PARTS

A. Tools and Spare Parts
   1. One set of all special tools required for normal operation and maintenance shall be provided as specified in Specification Section 01730, “Operation and Maintenance Data”.
   2. All spare parts shall be furnished in accordance with Specification Section 01730, “Operation and Maintenance Data”. Provide all spare parts in clearly identified, indelibly marked wooden crates suitable for long term storage.

B. All spare parts shall be plainly tagged, marked for identification and reordering and shall be delivered properly boxed.

PART 2 PRODUCTS

2.01 MANUFACTURER(S)

A. MagnaDrive Corporation

B. Or Owner/Engineer approved equal.

2.02 MATERIALS AND EQUIPMENT

A. General
   1. The magnetic coupling drive units shall be mechanical type devices, complete with a 120V linear actuator for controlling the speed of the pumps included with Specification Section 11312F, “Sewage Pumps, Self-Priming, Volute Mounted”:
      a. Service: Return Activated Sludge Pumping System
      b. Location: RAS Pump Station Nos. 1 and 2
      c. Number of Units: 5 (2 at RAS Pump Station No. 1 and 3 at RAS Pump Station No.2)
      d. Configuration: Horizontal
   2. The Return Activated Sludge Pumps will be used to pump activated sludge from the secondary clarifiers to RAS Splitter Box. Pumps will be operated at variable speed, controlled by an Adjustable Speed drive and should be provided with a shaft coupling that can be removed to allow installation of the drive.

3. The variable speed control system supplied shall control the speed of five (5) Return Activated Pumps while operating the motors at design speed.
4. The couplings shall be driven by motors with 1.15 service factors and shall operate without derating or requiring any motor modifications.
5. The magnetic clutch to be furnished under this Section shall be the products of a single manufacturer. The drives shall be MagnaDrive 10.5 ASD by MagnaDrive Corporation or Owner's Representative approved equal.
6. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's maximum speed performance curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than that specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc, required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Owner's Representative.
7. This Section is intended to give a general description of what is required but does not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover all materials, equipment, and appurtenances for the complete magnetic couplings as herein specified, whether specifically mentioned in this Section or not.
8. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in this Section or not, and as required for an installation incorporating the highest standards for the type of service.
9. The pump manufacturer shall factory mount all magnetic couplings to the pumps.
10. Each pump and magnetic coupling shall be designed to withstand the maximum turbining run-away speed of the pump due to backflow through the pump.
11. Pumps and pump bases shall have suitable provisions to accommodate the magnetic couplings.
12. The pump manufacturer shall supply a suitable coupling guard in accordance with OSHA regulations.
13. The pump motors shall conform with Specification Section 16222, "Electric Motors, Induction, 600 Volts and Below".

B. Magnetic Couplings
1. The Adjustable Speed Drive shall be a coupling of the air gap magnetic clutch type. The magnetic clutch shall transmit torque from the motor across the air gap to the pump.
2. The magnetic clutch shall consist of three sets of components: a magnetic rotor assembly that contains rare-earth magnets on the driven side of the coupling; a copper conductor rotor assembly on the driver side of the coupling, and; a linear actuator that controls the air gap spacing between the magnet and conductor rotors. Relative rotation of the copper conductor and magnet rotor assemblies will induce a coupling across the air gap. Varying the air gap spacing between the magnet rotors and the conductor rotors will result in controlled output torque and speed. The air gap spacing shall be varied by the movement of the linear actuator arm against the coupling control mechanism. Decreasing the air gap shall increase torque and rotational speed of the driven load. Increasing the air gap shall decrease torque and rotational speed of the driven load.

3. The linear actuator shall be UL listed, shall operate at 120VAC, and shall accept a 4-20mA signal to control pump speed. A feedback signal from the actuator will be provided for use within the process control logic.
4. There shall be no mechanical connection between the driving and driven sides of the equipment. The drive shall be corrosion resistant suitable for application in a wastewater treatment plant.

2.03 SURFACE PREPARATION AND PRIME SHOP PAINTING

A. Surface preparation and shop priming shall be part of the work of this Section and shall be as specified in Specification Section 09960, “High Performance Coatings”.

B. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Owner’s Representative up to the time of the final acceptance test.

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Installation shall be in strict accordance with the manufacturer’s instructions and recommendations in the locations shown on the Drawings. Follow manufacturer’s published instructions and alignment requirements for driven unit. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer’s recommendations. Anchor bolts shall be furnished and set in accordance with the manufacturer’s recommendations.

B. Supply all anchor bolts, temporary lift equipment, power, water, labor, and all other incidentals required for the proper installation of the pumps and their couplings.

C. After completion of all procedures specified above, clean and touch up any damaged coating system as required.

D. Lubricate and make unit ready for operation.

3.02 FIELD QUALITY CONTROL

A. Manufacturer’s Service
1. All final adjustments of equipment, controls and instruments to be performed by technicians representing the equipment manufacturers. Furnish service and training required in this Specification.

B. Field Testing: After completion of installation and prior to acceptance by the OWNER, CONTRACTOR shall demonstrate in the presence of the ENGINEER the functionality of all control panel functions and alarms. Field tests shall include all pumps with magnetic drives included under this Section.

C. If the magnetic coupling performance does not meet the specified requirements, corrective measures shall be taken or the magnetic couplings shall be removed and

replaced with pumps which satisfy the conditions specified. A 24 hour operation period of the pumps will be required before acceptance.

D. Placing in Service
   1. Before Start-Up:
      a. Check impeller and make sure all rotating elements are free and clear.
      b. Check direction of motor rotation with pump disconnected to ensure the direction of pump and motor are compatible.
      c. Have manufacturer's representative inspect and approve installation.
   2. Complete unit, when assembled and operating, to be free from excessive vibration, cavitation, and noise.

3.03 MEASUREMENT AND PAYMENT

No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 11317

SUBMERSIBLE MIXERS: HIGH-SPEED

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for providing submersible mixers and accessory items required for a complete and operable system.

B. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Tag numbers:
1. Submersible Mixer 1: AB-AXB1-MIX-01.
2. Submersible Mixer 2: AB-AXB1-MIX-02.
3. Submersible Mixer 3: AB-AXB1-MIX-03.
4. Submersible Mixer 4: AB-AXB1-MIX-04.
5. Submersible Mixer 5: AB-AXB2-MIX-01.
6. Submersible Mixer 6: AB-AXB2-MIX-02.
7. Submersible Mixer 7: AB-AXB2-MIX-03.
8. Submersible Mixer 8: AB-AXB2-MIX-04.
9. Submersible Mixer 9: AB-AXB3-MIX-01.
10. Submersible Mixer 10: AB-AXB3-MIX-02.
11. Submersible Mixer 11: AB-AXB3-MIX-03.
12. Submersible Mixer 12: AB-AXB3-MIX-04.
13. Submersible Mixer 13 AB-AXB4-MIX-01.
14. Submersible Mixer 14 AB-AXB4-MIX-02
15. Submersible Mixer 15 AB-AXB4-MIX-03
16. Submersible Mixer 16 AB-AXB4-MIX-04
17. One complete shelf spare.

1.02 REFERENCES

A. American Bearing Manufacturers' Association (ABMA):
1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Institute of Electrical and Electronics Engineers (IEEE):
1. 112 - Standard Test Procedure for Polyphase Induction Motors and Generators.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
1. The mixers shall be capable of handling raw, screened sewage and mixture of primary effluent and activated sludge.
2. The mixers shall be able to be raised and lowered and shall be easily removed for inspection or service without the need for personnel to enter mixing vessel.

3. A sliding guide bracket shall be an integral part of the mixer unit. The entire weight of the mixer unit shall be guided by a single bracket which must be able to handle all thrust created by the mixer.
4. The mixer, with its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 feet.

CHARACTERISTIC	VALUE
Propeller Flow, gpm	1,563
Propeller speed, maximum, rpm	900
Propeller diameter, inches	between 19.5 and 23.0 inches in diameter
Motor horsepower, maximum	3.0
Brake horsepower, minimum	2.1
Drive unit and propeller weight, maximum, pounds	300
Anaerobic/Anoxic selector zone dimensions:	
Zone length(1), feet	18
Zone width(1), feet	14.5
Zone side water depth(1), SWD (feet)	16.7
Note: (1) Zone 1 through Zone 4 are equal in size.	

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Motor information:
      a. Graphs of efficiency and power factor from 1/2 to full load.
      b. Factory test reports with test reference standard indicated. Include IEEE 112 Form B.
      c. Load calculations for allowable number of starts per hour.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Mechanical calculations and details including gear reducers.

E. Vendor operation and maintenance manuals: As specified in Section 01730 - Operation and Maintenance Manuals.

F. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCT

2.01 MANUFACTURERS

A. The following or equal:
   1. Wilo.
   2. Xylem Flygt.
   3. Landia.

2.02 SUBMERSIBLE MIXERS

A. Each mixer shall be of the integral design, close coupled submersible type.

B. Components of the mixer, including motor shall be capable of continuous underwater operation.

C. Capable of continuous operation completely unsubmerged for 2 hours.

D. Materials:
   1. Major mixer components: Type 316 stainless steel construction.
   2. Motor Housing: Ceramic coated or epoxy coated cast iron. AD5
   3. Oil housing cover plate: Corrosion resistant composite.
   4. Exposed nuts and bolts: Type 316 stainless steel.
   5. Propeller: Type 316 stainless steel.

E. Elastomers:
   1. Machine and fit mating surfaces where watertight sealing is required with a double set of Nitrile rubber or Viton™ o-rings.
   2. Accomplish sealing by metal-to-metal contact between machined surfaces resulting in controlled compression of the o-rings without requiring a specific torque limit.
      a. No secondary sealing compounds, rectangular gaskets, elliptical o-rings, grease, or other devices are allowed.

F. Propeller:
   1. Dynamically balanced, non-clogging backward curved design.
   2. Laser cut and weld each blade to the hub to ensure that the propeller is properly balanced or cast propellers are acceptable.
   3. Capable of handling solids, fibrous materials, heavy sludge, and other matter found in normal sewage applications.
   4. Design includes 3 vanes with a blade angle of 5 to 8 degrees.

G. Cable entry:
   1. Cable entry housing integral part of the back plate.
   2. Single sealing systems will not be accepted.
   3. Double set of elastomer grommets in order to ensure a redundant system in the event of cable entry failure.
   4. The cable entry shall be comprised of 2 cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof seal at the cable entrance without the need for specific torque requirements.
   5. The assembly shall bear against the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion.
   6. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top.
   7. Connection between the threaded compressed type binding posts permanently affixed to the terminal board and thus perfectly leak proof.
   8. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

H. Bearings:
   1. Bearing life: The minimum L-10 bearing life shall be 100,000 hours in accordance with ABMA 9 or ABMA 11.
   2. The outboard propeller bearing shall be an angular contact bearing.
   3. The motor shaft end shall be supported by 2 bearings.
      a. A roller and an angular contact bearing shall take up the axial and radial loads while an angular contact bearing shall take up the axial loads.
      b. The bearings shall be pre-loaded by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing life and seal life.
      c. Mixers without pre-loaded bearings will not be considered acceptable or equal.

I. Mixer Protection:
   1. Mixer protection system will be provided to protect pumps against the following:
      a. Overload.
      b. Overtemperature.
      c. Moisture detected.

J. Thermal sensors:
   1. Thermal sensors shall be used to monitor stator temperatures.
   2. The stator shall be equipped with 3 thermal switches embedded in the end coils of the stator winding. These shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

K. Jet ring assembly (if required by manufacturer):
   1. The mixer assembly shall incorporate a jet ring of full 360 degrees around the propeller.

2. A maximum clearance of 1-1/2 inches shall be maintained between the propeller tip and the shroud in order to maintain hydraulic efficiency and power consumption.

L. Oil housing:
1. The oil housing shall contain 2 compartments consisting of an inner and an outer section with 4 ports to connect and facilitate oil flow. In the event that the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by mean of a simple gravity process.

M. Mechanical seals:
1. Each mixer shall be provided with 2 sets of lapped end face type mechanical seals running in oil reservoirs for cooling and lubrication.
   a. The mechanical seals shall contain positively driven rotary silicon carbide/tungsten carbide face rings.
   b. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contain in the mixed media, only the seal faces of the outer assembly and its retaining clips shall be exposed to the mixed media.
   c. All other components shall be contained in the oil housing.
   d. All seal faces must also be capable of relapping.
2. The seals shall require neither maintenance nor adjustment, but shall be easy to check and replace.
3. Shaft seals without positively driven rotating members shall not be considered acceptable or equal.

2.03 MOTOR

A. General:
1. The multi-pole motor shall be directly connected to the propeller to produce a propeller speed of not more than listed on the mixer schedule.
2. The mixer motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber.
3. The stator winding shall be insulated with moisture resistant Class F insulation which will resist a temperature of 155 degrees Celsius (311 degrees Fahrenheit).
4. The stator shall be dipped and baked 3 times in Class F varnish.
5. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least 10 evenly spaced starts per hour.
6. The rotor bars and short circuit rings shall be made of aluminum.

B. Electric motor type:
1. Type: Horsepower provided on mixer schedule, submersible electric motors connected for operation on a 460 volt, 3-phase, 60 hertz, alternating current service.
2. Conductors: Conductors of adequate length with submersible cable.
3. Cables: Shall be oil resistant chloroprene rubber jacketed. Each unit shall be fitted with lifting cable of adequate length and strength to permit raising and lowering the mixer.

C. Motor efficiency and power factor:
   1. Efficiency: At full load and 75 percent load shall not be less than 70 percent.
   2. Power factor: At full load shall not be less than 73 percent.

2.04 MANUAL CRANE

A. The manual crane shall be supplied for each mixer and shall be capable of being removed from the mixer mounting location and used at a second mounting location when utilized in conjunction with the 2-inch system 4 mixer support cable.

B. The boom and winch shall be easily assembled and removed from the crane mast to better facilitate assembly and storage requirements, respectively.

C. The crane shall be capable of rotating a mixer 360 degrees.

D. The crane shall have a reach of 27 inches from the centerline of the crane mast to the centerline of the lifting cable.

E. Load capacity: The crane shall be capable of hoisting 550 pounds.

F. The winch shall be of marine grade construction.

G. The main body of the crane (excluding the winch) shall be of Type 316 stainless steel material of construction.

H. No less than 40 feet of Type 316 stainless steel cable (1/4 inch diameter) shall be supplied.

I. The entire manual crane assembly shall weigh no more than 85 pounds.

2.05 MIXER MOUNT ASSEMBLY

A. General:
   1. Stainless steel, mixer mount assembly kit shall be supplied by the mixer manufacturer for each mixer and used to mount the mixer during operation and to guide the unit during installation and removal from service.

B. Fabrication:
   1. Upper, lower, intermediate brackets, and structural spool support for intermediate brackets: Type 316 stainless steel.
   2. The upper bracket shall be fitted with a special receptacle that securely holds and supports the davit while the mixer is raised, lowered, installed, or removed from the tank. The davit shall be sufficient to safely raise and lower the mixture.
   3. The mixer mount assembly shall include a field adjustable length of Type 316 stainless steel mixer support cable assembly of adequate length:
      a. A mast shall securely interface with the mixer manufacturer's upper, lower, and intermediate brackets and integrate in such a way to securely support the mixer during operation.
      b. All support bracket assemblies shall be supplied by the mixer manufacturer only in order to ensure the integrity of the system under optional loads.

4. The assembly shall also be provided with cable holders to secure the mixer electric power cable (1 every 5 feet). Their purpose shall be to prevent the electric cable from becoming entangled in the mixer propeller during operation.
    a. In addition, the mast shall be constructed with a positioning locking plate which will work in conjunction with a lock pin on the upper holder to positively lock the mast in place at various operating angles.

2.06 FINISHES

A. Mixer manufacturer shall factory prime and coat all surfaces coming into contact with sewage, other than stainless steel and hot dip galvanized steel, with manufacturer's standard coating.

2.07 SPARE PARTS

A. Provide a complete shelf spare in addition to 4 sets total of the following items:
    1. O-rings.
    2. Bearings.
    3. Mechanical Seals.
    4. Power Cable Grommet.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as specified in Section 15050 - Common Work Results for Mechanical Equipment.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
    1. Provide certificates:
        d. Manufacturer’s Certificate of Source Testing.
        e. Manufacturer’s Certificate of Installation and Functionality Compliance.
    2. Manufacturer’s Representative onsite requirements:
        a. Installation: 1 trip, 2-day minimum.
        b. Functional Testing: 2 trips, 1-day minimum each.
    3. Training:
        a. Maintenance: 2 hours per session, 1 session.
        b. Operation: 1 hours per session, 1 session.
    4. Process operational period:
        a. As required by Owner or Contractor.

C. Source testing:
    1. Test as specified in Section 15958 - Mechanical Equipment Testing.
    2. Mixer:
        a. Test witnessing: Witnessed.
        b. Conduct Level 1 General Equipment Performance Test.

D. Functional testing:
   1. Mixer:
      a. Test witnessing: Witnessed.
      b. Operate mixers for a minimum of 24 hours with the basins full of water.
      c. After completion of 24-hour test, the equipment shall be removed from the tank and inspected by a factory-trained representative for leaks through the seals.
      d. Demonstrate that the mixers are easily placed and removed without draining the tank and that the mixers easily move up and down the mast assembly without binding or crabbing.
      e. Conduct Level 2 General Equipment Performance Test.
      f. Conduct Level 2 Vibration Test.
      g. Conduct Level 2 Noise Test.

END OF SECTION

[AD5] Addendum No. 5

SECTION 11323[AD5]

VORTEX GRIT CHAMBER EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the furnishing and installation of complete vortex grit chamber equipment in the proposed concrete Grit Basin as shown on PLANS and as specified herein. Each grit chamber shall be complete with gear motor, gear head, propeller drive tube, axial flow propeller, grit removal pump and auxiliary equipment as specified herein. All wetted parts in the grit basin shall be constructed of 304 stainless steel.

1.02 RELATED REQUIREMENTS

A. Review installation procedures under other Sections and coordinate with the work related to this Section.

B. Related work as called for on PLANS or specified in Attachment "A" to this Specification.

1.03 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. ASTM A48 – Standard Specification for Gray Iron Casting

1.04 DEFINITIONS (NOT USED)

1.05 PERFORMANCE

A. Per Attachment "A" to this Specification Section

1.06 SUBMITTALS

A. Furnish in accordance with Specifications Section 01300, "Submittals" and Section 01730, "Operation and Maintenance Data".
   1. Shop Drawings. In addition to the items specified in Specification Section 01300, "Submittals", furnish the following:
      a. Submit a list of not less than 5 installations where vortex grit removal equipment of the type and approximate size specified has been in successful operation for at least 2 years.
      b. Submit locations of the nearest permanent service headquarters for the sizes of equipment submitted.
      c. Submit descriptive literature including a cross-sectional view of each equipment item, which indicated materials of construction, weights, principal dimensions and other important details.
      d. Installation instructions and drawings showing anchor bolt locations, electrical, and piping connections.

e. Large-scale dimension drawings showing all units in orientation as shown on PLANS.
f. Description and quantity of each part supplied. Description to include catalog cuts and materials of construction.
g. Motor manufacturer's data sheets and drawings. Motor shop test results.
h. Performance curves for the proposed pump model to include flow versus head and motor horsepower requirements.
i. Schematic control and power wiring diagrams including interconnecting and internal wiring diagrams.
j. Control panel drawings.

2. Operation and Maintenance Manuals: Furnish in accordance with Specification Section 01730, "Operation and Maintenance Data":
   a. Operating and maintenance instructions and parts lists. A list of recommended spare parts other than those specified. Predicted life of parts subject to wear.
3. Certified Report: Furnish copies of a report prepared by manufacturer's technical representative certifying the following conditions.
   a. Submit manufacturer's certification that he has carefully examined the TECHNICAL SPECIFICATIONS in detail, including the arrangement and conditions of proposed electrical, mechanical and structural systems affecting the performance of the pumping equipment units, and the detailed requirements of manufacturing and subsequent installation of the equipment units.

1.07 QUALITY ASSURANCE

A. Standardization: All equipment specified herein to be furnished by a one supplier to ensure unit integrity.

B. System Coordination: CONTRACTOR is responsible for all details necessary to properly install, adjust, and place in operation complete working system.

1.08 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver to site undamaged.

B. Storage: Store above ground on platforms, skids, or other supports and protect from corrosion and mechanical damage in accordance with manufacturer's recommendations and instruction. Protect electrical components from condensation.

C. Handling: Handle unit to prevent damage during unloading and installation. Follow manufacturer's instructions on lifting and setting.

PART 2 PRODUCTS

2.01 MANUFACTURER(S)

A. Smith & Loveless, Inc.

B. Enviro-Care Company

C. Or Owner/Engineer approved equal

2.02 MATERIALS AND/OR EQUIPMENT

A. Equipment Description
   1. Influent is tangentially introduced into the vortex chamber where impeller blades create a forced vortex causing the organics to separate from the grit and to be lifted up with the effluent while the heavier grit particles settle to the bottom of the lower chamber. A grit pump shall pump the grit into a grit classifier.
   2. Grit Removal Mechanism to be located in a 12-foot inner diameter concrete basin located in an outdoor environment. Refer to PLANS for elevation of gearbox mounting and bottom of Grit Basin.
   3. All drives, lubrication, and support equipment shall be readily accessible from the top of the basins.

B. Grit Removal Mechanism
   1. Axial flow type propeller driven by a drive tube powered through a combination spur gear and turntable bearing driven by a totally enclosed helical gear motor.
   2. Fluidizing vane.
   3. Gears to be constructed of alloy steel, heat-treated and hardened.
   4. Helical gear motor to be totally enclosed to resist atmospheric corrosion and oil lubricated.
   5. Spur-Tooth Bull Gear
      a. Enclosed in an oil -lubricated heavy cast iron, ASTM A48, Class 30 gear case.
      b. Forged steel with minimum Brinell Hardness of 200.
   6. Pinion: Cut from high strength normalized steel and mounted on a minimum 21 inch diameter turntable bearing.
   7. All bearings of drive unit including the motor shall have a minimum B10 life of 50,000 hours. Turntable bearing supporting the propeller assembly shall have a 20 year B10 life.

C. Grit Well Cover Plate
   1. Floor plate to cover the grit hopper, constructed of 304 stainless steel plate.
   2. Two sections with lifting slots to allow access to the hopper.
   3. Circular opening centered over the hopper and sized to allow grit passage while minimizing organic capture. The floor plate shall not interfere with the operation of the grit removal mechanism or the fluidizing vane.

D. Influent Baffle
   1. Provide 304 stainless steel plate influent baffle with 304 stainless steel supports and fasteners to separate influent from effluent and to direct the grit downward towards the grit well.

E. Horizontal Vortex Type Slurry Pumps
   1. General:
      a. The pumps shall be designed for continuous operation and will be operated continuously or intermittently under normal service.
      b. The pumps shall be of a fully recessed, Slurry Type design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connection, so that solids are not required to flow through

the impeller. All flow path clearances within the pumps shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.

c. The impeller shall be constructed of 650 Brinell Ni-Hard and specifically designed to maintain hydraulic pumping performance as wear occurs.
d. The hydraulic design shall be such that the length of the impeller vane increases as wear occurs to the rim, allowing as-new or better pumping performance throughout the wear cycle of the impeller.
e. The hydraulic design of the impeller shall preferentially direct flow to a sacrificial, independently-replaceable suction piece. The suction shall be easily accessible and replaceable, without the need to disassemble any other component of the pump.
f. Pump-out vanes on the rear shroud of the impeller are not acceptable. Impellers of the radial design that incorporate the impeller in a recessed portion of the volute or wear plate are not acceptable.
g. A removable wear plate of Ni Hard shall be provided in back of the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing. The packing housing shall be a separate piece bolted to the bearing housing for ease of removal. Wear plates that incorporate a stuffing box are not acceptable.
h. The pump casing shall be of the two-piece radially split-type, with a separate and removable suction piece designed so that the impeller can be withdrawn without the need to remove the discharge casing or disturb the discharge piping. The casing shall be constructed so that it can be reversed for opposite rotation, and shall be of Ni-Hard.
i. The pump's head vs. capacity curve shall slope upward toward shutoff in one continuous curve with no points of inflection capable of causing hunting at any pump operational speed.
j. Pumps shall be equipped with slotted raised face flanges to receive 125 lb. standard bolting. Special case slots shall be cast in to retain bolts and to fasten the case to the bearing housing and to the intake for easy case removal.

2. Materials
   a. The parts exposed to abrasive wear including the pump case, removable suction piece, impeller, and wear plate shall be of all Ni-Hard material conforming to ASTM Designation A532-75 Class I, Type A, and shall have a minimum of 650 Brinell hardness for maximum wear resistance. Brinell values below this are not acceptable.
   b. Test bars shall be cast integrally with the case and suction piece and shall remain attached to the casting upon final delivery to the Owner. Test bars shall be of sufficient thickness to represent the average thickness of the cast part. After receipt of final delivery, the Owner may at any time prior to the final acceptance, remove the test bar and independently verify compliance to the material and hardness specification. Failure of the tested bars to meet the specified requirements shall be cause for rejection.
3. Bearing Housing
   a. The bearing housing shall be of cast iron, ASTM A48CL-25.
   b. The shaft shall be of ASTM A108, Grade 1141 (or equal) steel, and shall be protected throughout the packing area by a removable, hardened stainless steel shaft sleeve conforming to ASTM A 582 Type 416.

c. Bearings shall be oil bath lubricated. The oil reservoir shall be sealed at both ends to prevent entrance of foreign matter. The thrust bearings shall consist of three angular contact ball bearings for maximum protection from all thrust loads. The bearing housing will be equipped with a pressure venting device and oil fill and drain taps. A built-in sight glass shall be furnished to check proper oil level. The bearings shall be rated for a minimum B10 life of 100,000 hours, without credit for any rear pump-out vanes to balance hydraulic thrust.

4. Shaft Sealing (Mechanical Seal)
   a. A single cartridge mechanical seal shall be furnished in the pump. The seal shall utilize a rotational sealing ring mounted in an elastomer cup with an o-ring mounted stationary ring loaded by a non-fouling, conical spring encapsulated in Viton. Installation of the seal shall require no measurements or scribe marks on the shaft.
   b. The rotational sealing ring shall be made of tungsten carbide Grade VC 805, the surface of which shall be lapped to a flatness not to exceed three helium light bands and shall be bonded inside a Viton rubber cup, which shall have three (3) integrally molded anti-rotational lugs to prevent the rotary seal face from turning within the rotary body. Additionally, the rotary body shall have three (3) 1/8" solid stainless steel pins to also prevent the rotary seal face from turning within the rotary body.
   c. The stationary sealing ring shall be constructed of solid alpha-sintered type silicon carbide. The surface shall be lapped to a flatness not to exceed three helium light bands. The stationary ring shall have a slot milled on the side opposite of the mating side, which engages an anti-rotation pin. Stationary sealing rings of converted carbon or other surface-only treatments are not acceptable.
   d. The spring that loads the rotational sealing ring shall be cone-type, non-fouling design and shall run in the pumped product without fouling or hang-up. The spring metal material shall be SAE1095 Carbon Steel, ASTM A-682 heat-treated to a Rockwell C hardness of 45 to 50 and be totally encapsulated in Viton for protection from the pumped fluid. The product side of the spring shall have a minimum 1/4" thick Viton rubber covering for corrosion/abrasion protection. Seals which use single coil, multiple coil, bellows and rubber-in-shear designs are not acceptable.
   e. To minimize the number of points where the slurry must be sealed, the mechanical seal assembly shall have no more than three (3) o-rings: one (1) shaft sleeve o-ring, one (1) stationary face o-ring, and one (1) retainer o-ring. O-rings are to be made of Viton. Seals using more than three (3) o-rings are not acceptable.
   f. All metal components not encapsulated in Viton shall be constructed of abrasion-resistant CD4MCu ASTM A-743. Surface finish shall be a maximum of 64 RMS.
   g. The seal shall be capable of running with up to ± 0.025" radial shaft deflection and ± 0.040" axial shaft deflection without leakage, damage, or loss of performance.
   h. A seal chamber of Hi-chrome iron, ASTM A-532, minimum 600 Brinell, shall be provided to mount the seal and to provide a reservoir of adequate volume for the pumped product to contact and to lubricate the seal faces. The seal shall be installed into the seal chamber from the impeller side of the pump so that only the casing/suction piece and impeller need to be

removed to gain complete access to the seal for inspection and/or maintenance.

i. The mechanical seal shall be furnished with a flush water tap.

5. Mounting
   a. The pump and motor shall be mounted as shown on the Plans with V-belt drives between the motor and pump. The pump manufacturer shall provide a common pump and motor base constructed of a minimum 3/8" thick fabricated steel, suitably reinforced to support the full weight of pump and motor.
   b. The pump supplier shall furnish and mount a separate, adjustable motor base so that the motor can be easily moved for V-belt tensioning and adjustment. The pump supplier shall furnish and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions. The drive sheaves shall be of the stationary control variable speed T.B. Woods type “SVS”, or equal, that allows a speed change by means of an adjustment to the motor sheave when the drive is not in operation.
   c. An approved fiberglass or thermoplastic belt guard shall be provided to safely enclose the V-belt. The belt guard shall be attached to the pump frame at a minimum of four points. If metal guards are furnished, they shall be of all 304 stainless steel construction with suitable lifting eyes and handles to aid in removal.
6. Motors
   a. Each pump shall be driven by a single speed 5 HP, totally enclosed fan cooled, constant torque, premium efficiency motor wired for 460 volt, 60 cycle, 3 phase current. The motors shall be rated at 40°C ambient with Class F insulation and shall have a Class B temperature rise at full load. The motor shall have a service factor of 1.15 service factor and shall comply with the applicable provision of the Standards of NEMA. The minimum AFBMA B10 bearing life shall be 50,000 hours. The nominal motor speed shall be 900 rpm.

F. Controls
1. Main Control Panel
   a. Contractor to furnish and install a dedicated packaged control panel for the vortex grit chamber. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include equipment, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings. Control panel shall be provided in accordance with Specification Section 13390, “Packaged Control Systems”.
   b. Design: Factory-wired and tested control panel designed to function with equipment. For each individual item, control panel functions as defined on the Electrical and Instrumentation & Control Drawings.
   c. Panels materials and design to be specifically selected for durability and corrosion resistance, for unprotected installation outdoors in presence of intense sunlight and corrosive gases (hydrogen sulfide).
   d. Panel shall be designed to meet all NFPA 820 area classification requirements. The upper level of the Headworks is classified Class 1, Division 2. Panel shall be provided that satisfies all classification requirements.
2. Field Control Station

a. Contractor to furnish and provide field control stations for each item of equipment as defined on the Electrical and Instrumentation & Control Drawings.
b. Field control station shall be per Specification Section 16540, "Field Control Stations".

G. Corrosion Protection
1. All steel mechanical or structural components at or below the operation platform level shall be 304 stainless steel. All steel hardware, fasteners or anchors regardless of location shall be Type 316 stainless steel. Equipment above the operation platform level shall be coated per Specification Section 09960, “High Performance Coatings” with systems specified for Pipe and Valves - Exterior. Concrete surfaces below the operating platform level shall be furnished with Polybrid or equal corrosion-protective coating in accordance with Specification Section 09960, “High Performance Coatings”.
2. The pumps and motors shall receive a minimum shop-cleaned surface preparation equivalent to SSPC-SP-1 immediately prior to shop-priming and finish coating. Shop-priming and finish painting shall consist of a coating that is compatible with a high quality epoxy finish coating that is specifically resistant to chemical, solvent, salt water, and acid environmental conditions. Touch-up painting shall be the responsibility of the Contractor.

H. Spare Parts and Special Tools:
1. Provide one complete set of all spare parts recommended by manufacturer for first year routine and preventive maintenance.
2. Furnish one each of all special tools recommended by manufacturer for use in routine and preventive maintenance.

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Follow manufacturer’s and supplier’s instructions and approved shop drawings for installation of equipment.

B. After alignment is correct, grout using high grade non-shrink grout.

C. Lubricate and make unit ready for operation.

3.02 FIELD QUALITY CONTROL

A. Testing and Placing in Service
1. All final adjustments of equipment, controls, and instruments to be performed with assistance from technicians representing equipment manufacturer.
2. Coordinate start-up with other phases of construction for project. Instruct operating personnel concerning operating and maintenance procedures.

B. Manufacturer’s Services
1. Manufacturer’s technical representative to assist in the following services:
a. Checking installation of units.
b. Testing and adjustment of equipment mechanism.

c. Instruction of OWNER's personnel in the operation and maintenance of grit chamber system.

C. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, and a completed and signed pre-testing check list.

D. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct a running test and a performance test for each unit in presence of the Owner or Owner's Representative to determine its ability to deliver its rated capacity under specified conditions.
   1. Testing:
      a. Perform a test on each grit chamber to demonstrate the correct alignment, smooth operation, proper and equal spacing of propeller, freedom from vibration, excessive noise and overheating of the moving parts and bearings.
      b. The test runs on the grit pumps shall be undertaken with water in the grit settling tanks filled up to the high water elevation shown on the Drawings. The Contractor shall be responsible for providing sufficient water for filling the tanks for the test runs on the pumps. The test runs on the grit pumps shall determine acceptable normal running noise, speed and direction.
      c. All defects recorded during the above field tests and all defects and failures occurring within the first year of operation shall be corrected at no additional cost to the Owner.
   2. Performance Testing:
      a. During tests, observe and record flow rates, channel water depths, and motor inputs.
      b. Test Duration: Determined by the Owner or Owner's Representative, but not less than ten pump start cycles.
      c. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
      d. Repeat tests until specified results are obtained.
      e. Make all adjustments necessary to place equipment in specified working order at time of above tests.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

A. General
   1. Plant Flows
      a. Average Design Flow per Grit Basin: 2.25 MGD
      b. Peak Hydraulic Flow per Grit Basin: 9.0 MGD
   2. Flow in 12-foot diameter concrete grit removal basin shall travel between the inlet and the outlet a minimum of 360 degrees providing maximum travel of the liquid for effective grit removal.
   3. See PLANS for Grit Basin bottom elevation and mechanism drive mounting elevation.

B. Performance Requirements
   1. Grit Removal Mechanism
      a. Capable of Removing at Design Flow: 95% of the grit greater than 50 mesh in size, 85% of the grit greater than 70 but less than 50 mesh in size, and 65% of the grit greater than 100 but less than 70 mesh in size.
      b. Headloss through vortex grit chamber to ¼ inch or less.

C. Vortex Grit Basin Equipment Design/Dimensional Requirements
   1. Number of Units: 1
   2. Tag Numbers: HW-GRITMECH-01
   3. Influent Channel Width: 3 feet
   4. Effluent Overflow Width: 3 feet
   5. Lower Chamber (Hopper) Diameter: 5 feet
   6. Drive Motor: Per Specification Section 16222, "Electric Motors, Induction, 600 Volts and Below".
      a. Minimum Motor Horsepower: 1 HP
      b. Voltage: 460 volt, 3 phase, 60 Hertz
      c. Enclosure: TEFC-CISD
      d. Motor Space Heaters: Required

D. Grit Pump Equipment Design/Dimensional Requirements
   1. Type: Horizontal Vortex Slurry Pumps
   2. Number of Units: 1 installed and 1 spare
   3. Tag Numbers: HW-GRITPUMP-01
   4. Flow: 250 gpm
   5. Total Dynamic Head: 15 feet
   6. Solids Passage: 3 inches
   7. Minimum Suction Diameter: 3 inches
   8. Minimum Discharge Diameter: 3 inches
   9. Drive Motor: As Specified herein and Per Specification Section 16222, "Electric Motor, Induction, 600 Volts and Below".
      a. Minimum Motor Horsepower: 5 HP
      b. Speed: 900 rpm
      c. Voltage: 460 volt, 3 phase, 60 Hertz
      d. Enclosure: TEFC-CISD
      e. Motor Space Heaters: Required

END OF SECTION

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SECTION 11324

GRIT WASHER

PART 1 GENERAL

1.01 SUMMARY

A. Furnish, install and place in service one (1) grit washer for removing, washing and conveying grit particles before discharging the material into a dumpster as shown on PLANS and as specified herein.

B. The grit washer shall be complete with conical grit washer tank with flanged connections, tank cover with removable maintenance access hatch, central inlet vortex chamber that directs inflowing grit slurry in radial direction to a circumferential overflow weir, stirring device with gear motor, grit conveying and dewatering screw, screw conveyor gear reducer, controls and appurtenances.

C. It shall be the Contractor's responsibility to ensure that the grit washer and appurtenances furnished and installed shall be compatible with and have the necessary operating clearances to the structural elements and associated equipment shown on PLANS.

1.02 RELATED REQUIREMENTS

A. PLANS show general arrangement, location, and basic dimensions. Attachment "A" to this Specification Section gives performance and design requirements.

B. Related work as called for on PLANS or specified in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
      a. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
   2. AMERICAN WELDING SOCIETY (AWS)
      a. AWS D1.1 - Structural Welding Code - Steel

1.04 SUBMITTALS

A. Furnish in accordance with Specifications Section 01300, "Submittals" and Section 01730, "Operation and Maintenance Data".
   1. Shop Drawings: In addition to the items specified in Specification Section 01300, "Submittals", furnish the following:
      a. Large-scale certified shop and erection dimensioned drawings showing equipment in the orientation shown on PLANS. Drawings shall show important details of construction including dimensions, anchor bolts locations, and field connections.

b. Detailed description of construction, including parts list with materials of construction and metallurgy with ASTM designations.
c. Description and quantity of each part supplied, including catalog cut sheets, materials of construction, and spare parts list.
d. Descriptive literature, bulletins, and catalogs of the equipment, including details of the motor, gear reducer, and lubrication points.
e. Installation, operation, and start-up procedures. Equipment weight and lifting points for installation and removal purposes.
f. Motor manufacturer's data sheets and drawings. Motor shop test results.
g. Schematic control and power wiring diagrams including interconnecting and internal wiring diagrams.
h. Control panel drawings.

2. Operation and Maintenance Manuals: Submit operation and maintenance manuals in compliance with Specification Section 01730, "Operation and Maintenance Data".
3. Installation Report: Furnish to ENGINEER copies of certified report prepared by manufacturer's technical representative certifying satisfactory installation, operation, and in service placement of units.

1.05 SPARE PARTS

A. Spare Parts and Special Tools:
1. Provide one complete set of all spare parts recommended by manufacturer for first year routine and preventive maintenance.
2. Furnish one each of all special tools recommended by manufacturer for use in routine and preventive maintenance.

1.06 QUALITY ASSURANCE

A. Standardization: All equipment specified herein to be furnished by a single supplier to ensure unit integrity.

B. System Design: Contract Documents are intended to describe details of a complete equipment installation for the purpose specified. CONTRACTOR is responsible for all details necessary to properly install, adjust, and place in operation a working system.

C. Manufacturer shall have a minimum of ten (10) years experience producing equipment substantially similar to the required and shall be able to submit documentation of at least five (5) installations using the same size or larger equipment in satisfactory operation for at least five (5) years.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to work site in largest sections permitted by carrier regulations. Material to be free of dirt or other foreign matter and shipped with sufficient bracing, protection, etc., to ensure arrival in an undamaged condition. Flanges to have flange protectors. Bearings to be lubricated.

B. Storage: Store above ground on platforms, skids, or other supports, and protect from corrosion and mechanical damage. Protect electrical components from condensation.

C. Handling: Handle unit to prevent damage during unloading and installation. Follow manufacturer's instructions on lifting and setting.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the requirements of this Section, the following manufacturers have the capability of performing the work in this Section:
   1. HUBER Technology, Inc;
   2. Vulcan Industries, Inc.;
   3. Enviro-Care Company;
   4. Or Owner/Engineer approved equal

2.02 MATERIALS AND/OR EQUIPMENT

A. General
   1. Unless otherwise specified in these specifications, all components of grit washer equipment shall be manufactured from AISI 304L stainless steel. All mechanical parts shall be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according to the O&M manual.
   2. The entire equipment shall be manufactured in a stainless steel only factory to prevent contamination of the stainless steel with foreign contaminants.
   3. The equipment, after its fabrication, shall undergo a passivation process to ensure maximum resistance to corrosion. All stainless steel components and structures shall be submersed in a chemical bath per the methods described in ASTM-A380-99 to remove any residues that may be present on the material as a result of forming, manufacture, or handling. Spray on chemical treatments and glass bead blasting are not acceptable due to their inability to provide complete and uniform corrosion protection.
   4. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel.

B. Conical Grit Washer Tank
   1. A conical tank constructed from type 316 stainless steel with a minimum thickness of 1/8 inch shall be provided to house the grit washing components.
   2. Water containing grit from a grit chamber shall be introduced into the vortex chamber with a rotating flow pattern, and through the inlet distributor into the grit washer tank. The water flow is directed from an axial flow to a radial flow towards the overflow weir that is provided at the circumference of the grit washer tank. This change of the flow direction (coanda effect) leads to effective sedimentation of the grit towards the bottom of the grit washer tank.
   3. The tank housing shall be designed and built to withstand the maximum static and hydraulic forces based on the loads specified.
   4. The tank shall be completely covered to minimize odors and leakage. Cover shall be provided with removable hatch for maintenance access.
   5. The classified water shall pass over the overflow weir and discharge out of a single 8-inch clean water outlet. The overflow weir shall be constructed of 304 stainless steel with a minimum thickness of 1/8-inch.

6. A 4-inch connection with an automatically operated one quarter-turn ball valve shall be provided for removal of organic material out of the conical section of the tank. The ball valve shall be directly flanged to the conical tank without any adapter or connection pieces to avoid clogging issues. The ball valve shall have a stainless steel body and ball to prevent binding when in contact with abrasive materials. Metallic ball valves which can bind in highly abrasive applications shall not be acceptable. The stirrer shall move organic matter toward this connection.
7. A pressure transducer shall be provided at the base of the tank to measure the height of the grit level within the tank and to control the operation of the grit stirrer and grit removal screw. The pressure probe shall be suitable for installation in a Class 1, Division 1 hazardous location.

C. Fluidized Grit Bed
1. A fluidized grit bed shall be maintained in the bottom portion of the grit washer tank. Within this fluidized bed, the grit is intensively washed and organic material is effectively removed from mineral particles.
2. Wash water shall be introduced into the bottom of the grit washer and dispersed through a perforated neoprene diaphragm (2mm thick) to generate the fluidized bed in the bottom portion of the grit washer. This wash water shall also effectively flush the organic components out of the fluidized bed towards the overflow weir.
3. Wash water shall be controlled by a 1-inch diameter (minimum) solenoid valve, manual ball valve, pressure reducing valve, flow meter, and pressure gauge.
4. Wash water shall be distributed uniformly in order to reduce grit sedimentation on the bottom of the grit tank.

D. Grit Screw
1. Washed grit shall be removed through a central tube at the bottom of the grit washer. The stirrer shall move washed grit to the central tube. The grit to be removed shall drop into an auger inclined at 45 degrees. This auger shall dewater and convey the grit above the level of the overflow weir. The washed and dewatered grit is discharged at the upper end of the auger.
2. The screw conveyor housing trough shall be U-shaped made of minimum 10/64 inch thick stainless steel. The interior of the housing shall incorporate a minimum 3/8-inch thick UHMW polyethylene liner to prevent metal to metal contact between the screening housing and the screw. The liner shall be replaceable.
3. The transport area of the screw housing shall be furnished with removable cover panels. Resilient seals shall be mounted to the U-trough to prevent leakage between the trough and cover panels. The cover panels shall have a nominal thickness of 1/8-inch and be constructed of 304 stainless steel.
4. The grit screw shall be shafted and shall be made of stainless steel. The lower end of the screw shaft shall be supported by a chilled cast-iron stub bearing with a maintenance-free ceramic sleeve. Wear strips are not acceptable.
5. The grit screw shall have a minimum nominal outside diameter of 11-inches. The grit screw design shall have intelligent screw flights preventing clogging issues within the grit screw.
6. A screw drive shall be provided at the upper end of the auger. The motor shall be continuous duty rated and shall be selected to match the duty of the grit

conveying screw. The drive unit shall be directly coupled to the grit conveying screw drive shaft.

7. A discharge chute shall be provided to allow washed grit to be discharged into the appropriate receiving device. A flexible chute extension shall be provided to extend the bottom of the chute to within 2 feet of the top of the receiving device.

E. Grit Stirrer Assembly

1. The center stirrer shaft diameter shall be 60 mm and shall have a thickness of 5 mm. The stirrer arms shall be 30 mm in diameter and constructed of 304L stainless steel.
2. The stirrer shall consist of a minimum of 2 arm sections mounted to the center stirrer shafted drive unit. The stirrer design shall promote better discharge of organics, grit bed fluidization, and ability to discharge larger stones. Air and or water scouring shall not be acceptable for generating high turbulences in lieu of a slow speed stirrer.
3. An external bearing shall be mounted between the support plate and the gear box of the drive unit to support the overhung load of the mixer.
4. Grit stirrer assembly drive unit shall consist of a helical speed reducer and motor. The drive shall rotate the stirrer at the specified speed and shall be designed for 24 hour a day operation under normal moderate shock loadings.

F. Accessories

1. Organic Removal Ball Valve Operator: Furnish and install a 110VAC, single phase, electrically operated actuator to provide automatic control of the 4-inch ball valve. The actuator shall be suitable for operation in a Class 1, Division 2 hazardous location.
2. Grit Bed Level Sensor: A 110VAC, single phase pressure probe shall be factory mounted and calibrated in the bottom of the grit settling area to monitor the grit level within the tank and to control the operation of the grit stirrer and grit removal screw. The pressure probe shall be suitable for installation in a Class 1, Division 1 hazardous location.
3. Wash Water: Provide a minimum 1-inch diameter 110V, 60Hz, Class 1, Division 2 solenoid valve to control the wash water flow. The wash water manifold shall be provided with a variable area flow meter with a transparent PVC casing to allow visual inspection of the internal float for manual flow rate confirmation. The variable area flow meter shall be factory installed and attached to the grit washer unit before shipment.

G. Anchorage and Fasteners

1. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and washers shall be 304 stainless steel unless otherwise indicated in this specification. Anchor bolts shall be wedge or epoxy type.
2. Anchor bolts shall be set by the contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non shrinking grout.

2.03 CONTROLS

A. Main Control Panel

1. All controls necessary for the fully automatic operation of the grit washer shall be designed and manufactured by the grit washer manufacturer.
2. Contractor to furnish and install a dedicated packaged control panel for the grit washer system. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include equipment controls, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings. Control panel shall be provided in accordance with Specification Section 13390, "Packaged Control Systems".
3. Design: Factory-wired and tested control panel designed to function with equipment. For each individual item, control panel functions as defined on the Electrical and Instrumentation & Control Drawings.
4. Panels materials and design to be specifically selected for durability and corrosion resistance, for unprotected installation outdoors in presence of intense sunlight and corrosive gases (hydrogen sulfide).
5. Panel shall be designed to meet all NFPA 820 area classification requirements. The upper level of the Headworks is classified Class 1, Division 2. Panel shall be provided that satisfies all classification requirements.

B. Field Control Station
1. A local operator station shall be provided and shall be suitable for wall-mounting or factory mounted to a leg of the unit.
2. Contractor to furnish and provide field control stations for each item of equipment as defined on the Electrical and Instrumentation & Control Drawings.
3. Field control station shall be per Specification Section 16540, "Field Control Stations".

2.04 OPERATION

A. The electrical control system shall provide for automatic control of the grit washer via a signal from the feed pump control panel.

B. The grit washer washing sequence shall be initiated by remote control signals from the main control panel when the grit pump starts. As the sediment is pumped into the tank, the internal mechanical mixer shall start.

C. After the grit pump stops, the mechanical mixer shall run continuously for a predetermined amount of time. After the grit pump stops and after a programmed delay, water shall be pulsed into the tank.

D. After the cleaning cycle, the pressure transducer measures the grit bed and signals the discharge conveyor to periodically remove the grit.

2.05 PAINTING AND PROTECTIVE COATINGS

A. Electric motors, speed reducers and other non-stainless steel components to have manufacturer’s premium epoxy paint finish.

B. Apply rust-preventative compound to all machined, polished, and nonferrous surfaces that are not to be painted.

2.06 SOURCE QUALITY CONTROL

A. Steel fabrication to conform to AISC standards.

B. Equipment manufacturer's shop welds, welding procedures, welders and welding operators to be qualified and certified in accordance with the requirements of the latest edition of ANSI/AWS D1.1 "Structural Welding Code - Steel" published by the American Welding Society.

C. Factory Test: Prior to shipment, equipment to be tested to ensure the integrity of the completed assembly. Check for proper rotation and free and clear movement of all parts.

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Contractor shall install complete equipment in accordance with manufacturer's and supplier's instructions and approved shop drawings for installation of equipment.

B. Lubricate and make unit ready for operation.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Services
   1. Furnish services and training required in Specifications.

3.03 TESTING

A. The grit washer shall be factory assembled and factory run tested as a complete assembly. If the grit washer is manufactured outside of the United States, the equipment shall be factory tested at the point of manufacture and factory tested a second time in the United States prior to shipment to the jobsite. The testing shall be performed with the motor installed and the water lines shall be factory tested for leaks. The main control panel shall also be factory tested prior to shipment.

B. The grit washer shall also be field tested after erection in the presence of the Owner and Engineer to confirm and verify the structural and mechanical compliance to the specification. The field acceptance test shall include demonstrating that the grit washer operates without vibration, jamming or overheating and perform its specified function satisfactorily.

C. Performance Requirements
   1. Prior to performance test, washer shall have completed 120hr systems demonstration test, and grit shall be produced from grit discharge minimum of one week prior. If grit has not yet discharged from unit(s) within one week of performance test, manufacturer shall supply and fill unit(s) with amount of sand recommended in order to create a base and start producing grit. Unit(s) shall operate for one week following addition of supplemental sand prior to start of performance test.
   2. Manufacturer shall guarantee and demonstrate that the grit washer(s) supplied shall meet the following performance requirements:

a. Grit Washer(s) shall be capable of accepting minimum flow of 250gpm from grit storage hopper of grit removal system containing grit, and possibly other settleable solids including vegetable matter, cigarette butts, popsicle sticks, rags etc, without plugging problems and loss of performance stipulated herein.
b. Grit discharged to dumpster for disposal shall be clean with solids containing no visible fecal matter, and shall be free of putrescible odors.
c. Washer shall operate reliably without breakdown or stoppage due to blockage at all design conditions and shall require minimal operation and maintenance.

3. Test Procedure
   a. As a requirement of this specification the manufacturer shall demonstrate that the grit washer(s) conform with the performance and operating criteria specified herein and the following tests shall be conducted at site on each operating grit washer unit:
      1) Contractor shall provide clamp on type flow meter and shall be attached to grit delivery pipe from the grit pump and after calibration, flow readings shall be taken for a minimum three pumping cycles, or over one half hour of continuous run time, to demonstrate the grit classifier is operating at the specified flow.
   b. The test results and observations shall be submitted for approval and acceptance by OWNER.
4. Owner shall furnish labor for each sample collection and the manufacturer shall pay cost of laboratory analysis as specified herein, unless otherwise negotiated with owner. Performance analysis will be carried out at laboratory approved by owner.

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

A. General: It is the intent of this Section to specify a machine that is corrosion resistant. Unless otherwise noted in this Specification all materials and fasteners to be AISI Type 304 stainless steel.

B. Performance Requirements: System consistently to remove a minimum of 95% of 200 micron grit, minimum of 95% volatile solids content, and 90% water content from the grit slurry.

C. Design/Dimensional Requirements
   1. Number of Units: 1
   2. Tag Numbers: HW-GRITWASHER-01 (Grit Washer No. 1)
   3. Grit Slurry Design Flow Rate: 250 gpm
   4. Grit Slurry Maximum Flow Rate: 250 gpm
   5. Grit Processing Capacity: 200 cfh
   6. Connection Sizes:
      a. Grit Washer Tank Inlet Connection: 6-inch flanged
      b. Overflow Connection: 8-inch flanged
      c. Organics Removal Connection: 4-inch flanged
      d. Tank Drain Connection: 3-inch with a ball valve and a 3/4-inch flush connection with the ball valve.
   7. Wash Water Supply: minimum 22 gpm with a minimum pressure of 29 psi with a single 1-inch connection
   8. Grit discharge height above operating floor: minimum 8 feet.

D. Drive Motor Data
   1. Grit Screw
      a. Minimum Horsepower: 1.5
      b. Maximum Motor Speed: 1,800 rpm
      c. Service Factor: 1.15
      d. Rating: 460V, 3-phase, 60 Hz
      e. Location Rating: Class 1, Division 2
      f. Torque must be sufficient to start and operate grit washer without exceeding nameplate ratings for current and power.
   2. Grit Stirrer
      a. Minimum Horsepower: 0.75
      b. Maximum Motor Speed: 1,800 rpm
      c. Service Factor: 1.15
      d. Rating: 460V, 3-phase, 60 Hz
      e. Location Rating: Class 1, Division 2
      f. Torque must be sufficient to start and operate grit washer without exceeding nameplate ratings for current and power.

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SECTION 11327

MULTI-RAKE SCREENS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install front cleaned mechanically cleaned bar screen(s) with multi-rake blades as shown on PLANS and as specified herein. Each unit to consist of bar rack, discharge chute, diverter chute, side frames, covers, rake blades, drive chains, scraper assembly, drive motor, anchor bolts, associated controls and all accessories and appurtenances required for a complete and properly operating installation.

B. Test mechanically cleaned multi-rake screens, gear reducers, motors, controls and appurtenances as indicated and in compliance with Contract Documents.

1.02 RELATED REQUIREMENTS

A. PLANS show general arrangement, location, and basic dimensions. Attachment “A” to this Specification Section gives performance and design requirements.

B. Related work as called for on PLANS or specified in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. American Iron and Steel Institute (AISI)

B. American National Standards Institute (ANSI)

C. American Society for Testing and Materials International (ASTM)

D. American Welding Society (AWS)

E. National Electrical Manufacturers Association (NEMA)

1.04 SUBMITTALS

A. Submit the following shop drawings in accordance with Specification Section 01300, “Submittals”:
   1. Certified shop and erection drawings showing important details of construction including dimensions, anchor bolt locations, and field connections. General arrangement drawings, plan and section showing bar rack, rake blades, chutes, supports and all process equipment interfaces. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified.
   2. Descriptive literature, bulletins, and catalogs of the equipment, including details of the motor, gear reducer, and lubrication points.

3. Drawings showing materials of construction, thicknesses, operating and maintenance envelope and assembly weight.
4. Installation, operation, and start-up procedures. Equipment weight and lifting points for installation and removal purposes.
5. Motor manufacturer's data sheets and drawings. Motor shop test results.
6. Schematic control and power wiring diagrams including interconnecting and internal wiring diagrams.
7. Control panel drawings.

B. Furnish in accordance with Specification Section 01730, "Operation and Maintenance Manuals":
   1. Operating and maintenance instructions and parts lists. A list of recommended spare parts other than those specified. Predicted life of parts subject to wear.

C. Installation Report:
   1. Furnish copies of certified report prepared by Manufacturer's technical representative certifying satisfactory installation, operation, and in service placement of units.

1.05 SPARE PARTS

A. Provide spare parts that are identical to and interchangeable with similar parts installed.
   1. Furnish following spare parts:
      a. Two (2) wiper blades.
      b. Two (2) cog wheel assemblies.
      c. 50 rollers and bushings for pin rack.
      d. Two (2) limit switches.
      e. Two (2) guide rollers.
      f. Two (2) rake teeth assemblies (each assembly shall provide one complete rake tooth replacement).
      g. Pins, rollers and bushings to replace 10 feet of pin rack.
   2. One set of all special tools required.

1.06 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01400.

B. Equipment specified shall be the product of a single manufacturer.

C. The Contractor shall obtain the screens, gear reducers, motors and appurtenances from the mechanically cleaned multi-rake screen manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system. Contractor responsible for all details necessary to properly install, adjust, and place in operation complete working system.

D. Equipment specified shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

E. Screen will be fully assembled and run tested to confirm fit and function of the screen. A certificate of the shop run test shall be supplied with the shipping documents.

F. Manufacturer of specified equipment shall have a minimum of five (5) operating installations with equipment of the size specified and in the same service as specified operating for not less than five (5) years.

G. If equipment proposed is heavier or taller, different width, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

H. Provide fabrication in compliance with all applicable ASTM standards or equivalent international standards.

1.07 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver to site undamaged.

B. Storage: Store above ground on platforms, skids, or other supports, and protect from corrosion and mechanical damage in accordance with manufacturer's recommendations and instruction. Protect electrical components from condensation.

C. Handling: Handle unit to prevent damage during unloading and installation. Follow manufacturer's instructions on lifting and setting.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Screening system capacities and operating data are indicated in Attachment "A" to this Specification Section.

B. The screening system shall positively capture and remove debris from the incoming wastewater by means of a bar rack, installed in a concrete channel designed to retain debris. A traveling raking mechanism removes and elevates the debris to a discharge wiper mechanism. The bar rack shall be cleaned by multiple rakes engaging the upstream side of the bar rack from the bottom of the channel and removing the debris. Screen designs that rely on the upward travel of the rake drive to pull the rake over an obstruction are not acceptable.

C. Screenings debris shall be lifted above the top of the channel and discharge through the downstream side to a screenings conveyor as indicated.

D. The screen shall be designed and built to withstand maximum possible static hydraulic forces exerted by the liquid to the screen. Provide a screen capable of operating with the screen 50 percent blinded and structurally capable of 100 percent blinded. All structural and functional parts shall be sized to prevent deflections or vibrations that may impair the screening operations.

E. The screen shall be fully enclosed above the channel level with bolted front and rear covers. Covers shall have doors or sections that can be opened or removed without having to undo bolts/nuts.

F. Design unit's cleaning cycle to be remotely initiated by the treatment plant's DCS system, but with local automatic control based on a timer or differential headloss, or by manual hand switches.

G. The Contractor shall coordinate the details, dimensions, and operating requirements of the screening system, including the conveyor, screenings washing press, and containers, in order to effect an arrangement that will provide a safe and efficient means for handling screenings. To this end, the actual dimensions and arrangements as shown may vary, if required, to improve operations.

2.02 MANUFACTURERS

A. Enviro-Care Company

B. Vulcan Industries, Inc.

C. Or Owner/Engineer approved equal

2.03 EQUIPMENT

A. Frame Assembly
   1. The framework of the screen shall be constructed of type 304 stainless steel. The frame shall be designed to support all required loads.
   2. The side frames shall be 304 stainless steel plate minimum 3/8-inch thickness formed to a channel profile, with a minimum width of 20-inches and extend fully from the bottom of the channel to the top of the bar screen assembly. The frame shall have a minimum of two support beams on the front above the maximum water line. No braces, gussets or stiffeners shall be inside the Screen Frame that will allow for Screenings to collect.
   3. Chain guide shall be securely bolted to the screen frame for the full height of travel and shall not protrude into the flow. The chain guide shall accurately align the rake teeth immediately into the screen bars starting at the bottom of the bar field and maintain positive engagement in the bar rack field. The chain guides shall be manufactured of 3" x 1-1/4" x 10-gauge 304 stainless steel.
   4. The screen shall be mounted by fastening to the top of the channel. The screen mounting system shall be constructed of 304 stainless steel and complete as required to function in accordance with the specification.

B. Bar Rack
   1. The bar screen shall be provided with a bar rack constructed of 304 stainless steel. The bar rack shall consist of trapezoidal bars, equally spaced and inclined from the horizontal as indicated.
   2. The bar rack shall extend from the base plate to the connection point on the dead plate. Screens with bars welded or bolted in place are not acceptable.
   3. The lower base plate and bar rack design shall allow solids to be picked from the bottom of the base plate and allow immediate engagement into the lower portion of the bar field. Designs that do not allow for positive immediate engagement to the bar field are not acceptable. Provide the bar rack extending the full depth of the channel.

C. Rake and Chain Assembly
   1. The rake drive chains shall be equal in pitch to the upper drive sprockets and the lower and mid-level guide sprockets. The chain for the rakes shall be roller type chain constructed of type 304 stainless steel. Rollers shall be 304 stainless steel. Pins shall be hardened stainless steel. Chain shall have a maximum design operating force of 24,000 lbs.
   2. Drive chains, chain guides, sprockets and their bearings shall be replaceable without removing the screen from the channel. Chain shall not require lubrication.
   3. Each screen shall be provided with sprockets a minimum 25 mm thick with 125 mm pitch from 304 stainless steel. Sprocket pitch and width shall match the roller chain.
   4. Upper drive shaft bearings shall be grease lubricated take up bearing. The take up screw shall be an acme thread type from type 18-8 stainless steel. The casing shall be made of paint coated cast iron.
   5. Lower and mid-level bearings shall be proven self-lubricating fiber reinforced PTFE material and shall be maintenance free. A ceramic or hardened steel collar shall be bonded onto the stub shaft. No lower or mid-level bearing requiring lubrication shall be allowed.
   6. Rakes shall be designed to lift the screenings removed from the bar rack to the discharge point. The rake blades shall have teeth precision cut from a single continuous bar of type 304 stainless steel with 1/2-inch thick rake teeth/bar and 1/4-inch thick reinforcement profiles. Teeth shall engage into the bar rack a minimum of 50% of the bar depth. Rakes shall be provided with a shelf of shovel shape to contain the collected screenings and prevent them from falling back into the channel. Rake teeth shall meet the bottom curved base to ensure removal of solids from the channel invert and shall then immediately positively engage the bottom of the bar screen grid. Screens that allow the rakes to float and jump over debris shall not be allowed.

D. Dead Plate
   1. The bar screen shall be provided with minimum 1/4-inch thick type 304 stainless steel fixed dead plate extending from the upper portion of the bar rack to the screenings discharge point.
   2. The head of the rake teeth shall first transition to a curved dead plate and then to the flat dead plate. Rake teeth shall closely follow the curved and flat portion of the dead plate riding no closer than 1/32-inch and no further than 1/4-inch from the dead plate. Dead plate shall be securely bolted to the side frames with no gaps.
   3. Designs in which the dead plate does not extend to the point of discharge shall not be allowed.

E. Discharge Chute
   1. A full discharge chute enclosure shall be provided. An access hatch with hinges and a handle shall be provided in the chute facilitating wiper replacement.
   2. The discharge chute shall be mounted to direct screenings into the screenings collecting unit. The chute shall have a slope of minimum 45 degrees. The discharge chute shall be made of a minimum 1/8-inch thick 304 stainless steel plate.

F. Diverter Chute Assembly

1. Provide a diverter chute that includes an integral pivoting chute for emergency use to divert screenings over the screenings conveyor and into a temporary receptacle.
2. 11 gauge minimum Type 316L stainless steel.
3. Suitably reinforced to support weight of screenings without causing damage to the discharge chute when in use.
4. Provide a framework of minimum 3/16-inch stainless steel plate with a diverter plate of minimum 11 gauge welded to a Schedule 40 Pipe of diameter 1 inch. The pipe shall be then attached to a handle. A desired position of the diverter plate is selected by means of the handle to either allow or not allow the screenings to fall into the conveyor hopper. The screenings diverter plate shall close any gaps with the discharge chute of the bar screen when the intention is to divert the screenings, over the top of the conveyor, into a disposal container.
5. Mount diverter chute out of the normal screenings discharge path.
6. Coordinate discharge chute dimensions with screenings conveyor equipment and connecting piping.

G. Wiper Assembly
1. A pivoting wiper mechanism shall be positioned at the point of discharge and shall be attached to the side frames and fully contained inside the framework of the screen. The scraper, excluding the wiper blade, shall be constructed of type 304 stainless steel. The wiper blade shall be manufactured of UHMW-PE.
2. The wiper shall clean the rake on each pass and return to its rest position with minimal shock. The wiper shall be designed such that screenings do not wrap around the rake or wiper. Wiper shall allow the rake assembly to operate in reverse without the need to manually lift the wiper assembly.
3. The wiper shall clean the rake on each pass and return to its rest position with minimal shock. Shock absorbers shall be provided to cushion the release of the wiper.

H. Frame Enclosure/Cover
1. The screen shall be provided with removable, stiffened covers made of 1/8-inch thick 304 stainless steel on the upstream portion of the bar screen above the operating floor held in place by latches. Covers shall be provided with minimum two handles per cover panel. All handles and latches shall be 304 stainless steel.

I. Drive Assembly
1. The drive gear reducer and motor shall be mounted on the drive shaft and the frame. The drive shaft shall be from steel and be mounted between greaseable bearings mounted on the external side of the frame.
2. The screen shall be provided with a helical worm gear reducer. Gear reducer shall have ball or roller bearings throughout with all moving parts immersed in oil. Gear reducers which require periodic disassembly of the unit and manual re-greasing of bearings are not acceptable. The nominal input power rating of the gear reducer shall be at least equal to the nominal horsepower of the drive motor. Gear reducer shall be designed and manufactured in compliance with applicable AGMA or equivalent standards.
3. The rake assemblies shall be driven by an electric motor. The motor shall be UL rated for operation in the specified installation environment. The motor

shall be a minimum 1.0 HP, TEFC, 460 Volts, 60 Hz, 3-phase, with a service factor of 1.15. The motor shall be rated for operation in a 104º F environment.

4. The screen shall automatically reverse and self-clean upon detection of a jam condition. A true power monitor controller shall be mounted in the screen control panel to detect and monitor the force generated by the gear reducer and when the force exceeds the high torque set point the screen shall be in jam mode. Jam mode will cause the screen to enter the self-cleaning mode. The screen shall automatically stop and run in reverse for the time value entered into the control panel. The screen shall then stop and run forward. If the cause of the jam condition is cleared the screen will resume normal operation. If the jam condition is detected again the reversing cycle shall repeat itself up to four (4) times. If the self-cleaning mode should prove unsuccessful then the screen shall stop and the control system will initiate an alarm signal.
5. Chain drives, belt drives, and hydraulic drives will not be accepted.

J. Level Detector
1. Provide two (2) Milltronics HydroRanger 200 ultrasonic differential level controller or equal for start and high-level sensing. The level detectors shall be supplied with mounting brackets constructed from type 304 stainless steel.

K. Proximity Switches
1. A NEMA frame mounted end of travel proximity switch to allow parking of the rake heads following completion of the cleaning cycle and to count rake cycles.
2. Proximity switch shall be single pole, double throw (SPDT) and rated not less than 10 amps at 120 volts AC.

2.04 CONTROLS

A. Main Control Panel
1. The control system shall be designed and manufactured by the bar screen manufacturer.
2. Contractor to furnish and install a dedicated packaged control panel for each bar screen. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include equipment controls, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings. Control panel shall be provided in accordance with Specification Section 13390, "Packaged Control Systems".
3. Design: Factory-wired and tested control panel designed to function with equipment. For each individual item, control panel functions as defined on the Electrical and Instrumentation & Control Drawings.
4. Panels materials and design to be specifically selected for durability and corrosion resistance, for unprotected installation outdoors in presence of intense sunlight and corrosive gases (hydrogen sulfide).
5. Panel shall be designed to meet all NFPA 820 area classification requirements. The upper level of the Headworks is classified Class 1, Division 2. Panel shall be provided that satisfies all classification requirements.

B. Field Control Station

1. Contractor to furnish and provide field control stations for each item of equipment as defined on the Electrical and Instrumentation & Control Drawings.
2. Field control station shall be per Specification Section 16540, "Field Control Stations".

2.05 OPERATION

A. Screen Hand Operation: In HAND position the operator shall be able to run the rake assembly by selecting the respective FORWARD-OFF-REVERSE selector switch. Turning the screen selector switch to Off will stop the unit.

B. Screen Automatic Operation: In AUTO position the screen shall be controlled by the water level sensors. Screen operation shall be started when the water level sensors monitor a certain water level difference, when the sensor senses high upstream water level, high differential, or when a certain time has passed since the last operation of the screen. Screen operation shall be stopped with an adjustable delay time after the water difference is below a certain value and after the sensor reads the correct water level, or after a certain run time has expired (if operation was started by timer).

C. Fault Conditions:
1. Excessive motor power will trip the starter overload relays, immediately stop the drive motor, and illuminate the alarm indicating light. This fault must be reset by depressing the motor starter overload reset internal to the control panel.
2. If the panel mounted true power monitor controller senses a high torque condition (jam), the screen shall automatically stop and run in reverse for the time value entered into the control panel. The screen shall then stop and run forward. If the cause of the jam condition is cleared the screen will resume normal operation. If the jam condition is detected again the reversing cycle shall repeat itself up to four (4) times. If the self-clearing mode should prove unsuccessful then the screen shall stop and the control system will initiate an alarm signal.
3. Reset is manually performed after correction of any cause for a trip-out.

2.06 ANCHORAGE AND FASTENERS

A. Anchor Bolts: All anchor bolts shall be a minimum of 1/2 inch diameter and made of type 304 stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.

B. Fasteners: All fasteners shall be type 304 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

2.07 PROTECTIVE COATINGS

A. Stainless steel and plastic components shall not be coated. The stainless steel structural components shall be passivated per the methods described in ASTM A380-99, after fabrication to remove embedded iron, surface rust and weld burn.

B. All other surfaces shall be solvent cleaned to remove dirt, oil and foreign materials. Cleaned surfaces shall be coated with one (1) coat of TNEMEC Series N69-1212

primer, or equal, to attain a minimum dry film thickness of 3-5 mils. The motor and gear reducer shall be finish coated with one (1) coat TNEMEC Series 1074 Endura-Shield, or equal, to attain a total minimum dry mil thickness of 3-5 mils. The finish coat shall be red in color and semi-gloss in finish, unless otherwise specified.

C. Non-stainless steel controls panels shall have Manufacturer's standard paint finish.

D. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 EXECUTION

3.01 INSTALLATION

A. Follow manufacturer's and supplier's instructions and approved shop drawings for installation of equipment.

B. After alignment is correct, grout using high grade non-shrink grout.

C. Lubricate and make unit ready for operation.

3.02 FIELD TESTING

A. Testing and Placing in Service
   1. All final adjustments of equipment, controls, and instruments to be performed with assistance from technicians representing equipment manufacturer.
   2. Coordinate start-up with other phases of construction for project. Instruct operating personnel concerning operating and maintenance procedures.

B. Manufacturer's Services
   1. Manufacturer's technical representative to assist in the following services:
      a. Checking installation of units.
      b. Testing and adjustment of screen mechanism.
      c. Instruction of OWNER's personnel in the operation and maintenance of screens.

C. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, and a completed and signed pre-testing check list.

D. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct a dry running test and a performance test for each unit in presence of the Owner or Owner's Representative to determine its ability to deliver its rated capacity under specified conditions.
   1. Dry Testing:
      a. Conduct test of each screen to simulate a blockage in the screen and to test the attempt to clear the blockage. Use the test to adjust the trip setting of the device.
      b. Modified anchor bolts supplied by the equipment manufacturer shall be bolted to the screen bars for the test. The anchor bolting arrangement shall be suitable for the loads applied and simulate solids jamming the

screen bars. A suitable means determined by the equipment manufacturer and acceptable to the Owner shall be employed to measure the load developed by the drive mechanism upon encountering the simulated blockage. Use the measured load to adjust the trip setting based on the recommended setting provided by the equipment manufacturer in advance of the test.

c. Make all necessary adjustments and settings to the drive mechanism and tripping device at the time of the test to ensure that the mechanical bar screen rakes will stop at the appropriate trip setting, reverse direction of travel for the appropriate distance, and then resume forward travel three times when the blockage is encountered, and will stop the screen at the fourth attempt and generate an alarm.

d. Perform a dry test on each mechanical bar screen to demonstrate the correct alignment, smooth operation, proper and equal spacing of screen bars, freedom from vibration, excessive noise and overheating of the moving parts and bearings.

e. Perform a dry test on each screen to demonstrate the ability of the screen to successfully handle large objects of the size and weight occasionally encountered in unscreened raw wastewater from a combined sewer system.

f. All defects recorded during the above field tests and all defects and failures occurring within the first year of operation shall be corrected at no additional cost to the Owner.

2. Performance Testing:

a. During tests, observe and record flow rates, channel water depths, headloss, and motor inputs.

b. Test Duration: Determined by the Owner or Owner's Representative, but not less than ten cycles.

c. Each screen must demonstrate thirty (30) days of continuous, defect-free operation prior to final acceptance.

d. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

e. Repeat tests until specified results are obtained.

E. Make all adjustments necessary to place equipment in specified working order at time of above tests.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

A. General: The screen system shall be installed in an environment that can be generally classified as highly corrosive. It is the intent of this Section to specify a machine that is corrosion resistant. Therefore, unless otherwise noted in this Specification, all materials and fasteners to be AISI Type 316 stainless steel. AISI Type 304 stainless steel is not acceptable.

B. The screen system shall be installed in channels with NEC, Class I, Division 2, Group D ratings.

C. Design Requirements:

1. Number of Units: 2
2. Equipment Numbers: HW-SCREEN-01 (Screen 1), HW-SCREEN-02 (Screen 2)
3. Average Design Flow per Screen: 2.25 MGD
4. Peak Flow per Screen: 4.5 MGD
5. Channel Width: 3 feet
6. Channel Depth: 4.5 feet
7. Discharge Height Above Operating Floor Level: 3.7 feet, as shown on PLANS or as required to discharge to screw conveyor
8. Maximum Downstream W.S. Depth: 1.5 feet
9. Clear Opening Between Bars: 1/4″
10. Bar Rack Inclination: 75-degree angle from horizontal
11. Rake Speed: 10 fpm
12. Bar Field Engagement Time: No more than 15 seconds between engagement
13. Removal/Lifting Capacity: 0.25 cubic feet of debris per foot of rake width per cycle

D. Drive Motor Data:

1. Minimum Horsepower: 1.0 HP
2. Voltage: 460 volts, 3-phase, 60 Hz
3. Enclosure: Designed for use in a Class I, Division 2, Group D location; TEFC severe-duty

END OF SECTION

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SECTION 11333

SCREENINGS WASHER COMPACTOR

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the furnishing and installation of screening washer compactor equipment for washing, dewatering, compacting, and conveying screenings material for disposal.

B. Screenings washer compactor shall consist of a flange mounted gearmotor, spiral with separate thrust bearing, wash water spray system, stainless steel trough, wash zone, press zone, discharge piping, electrical controls, and all other appurtenances required or shown on PLANS. Equipment shall be installed as shown on the PLANS and as specified herein.

C. Electric motors shall be furnished as part of the work of this Section and shall conform to all applicable portions of Specification Section 16222, “Electric Motor, Induction, 600 Volts and Below”.

1.02 RELATED REQUIREMENTS

A. PLANS show general arrangement, location, and basic dimensions. Attachment “A” to this Specification Section gives performance and design requirements.

B. Related work as called for on PLANS or specified in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

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

American Society for Testing and Materials (ASTM) Publications

ASTM A322	Carbon and Alloy Steel Bar Specifications
ASTM A507-10	Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold Rolled

Anti-Friction Bearing Manufacturers Association (AFBMA)

AFBMA 9-90	Load Ratings and Fatigue Life for Ball Bearings
AFBMA 11-90	Load Ratings and Fatigue Life for Roller Bearings

American Institute of Steel Construction (AISC)

American Welding Society (AWS) Publications

American Structures Painting Council (ASPC)

1.04 DEFINITIONS (NOT USED)

1.05 PERFORMANCE REQUIREMENTS

A. Reference Attachment “A”.

1.06 SUBMITTALS

A. Furnish in accordance with Specifications Section 01300, “Submittals” and Specification Section 01730, “Operation and Maintenance Data”.
   1. Shop Drawings. In addition to the items specified in Specification Section 01300, “Submittals”, furnish the following:
      a. Certified shop and erection drawings showing all important details including materials of construction, dimensions, loads on supporting structures, and anchor bolt locations.
      b. Descriptive literature, bulletins and/or catalogs of the equipment, including details of the motor, gear reducer, and lubrication points.
      c. Drawings showing materials of construction, thicknesses, operating and maintenance envelope and assembly weight.
      d. Installation, operation, and start-up procedures. Equipment weight and lifting points for installation and removal purposes.
      e. Motor manufacturer’s data sheets and drawings. Motor shop test results.
      f. Wiring diagrams and electrical schematics for all control equipment to be furnished.
      g. Control panel drawings.

B. Furnish in accordance with Specification Section 01730:
   1. Operating and maintenance instructions and parts lists. A list of recommended spare parts other than those specified. Predicted life of parts subject to wear.

C. Installation Report:
   1. Furnish copies of certified report prepared by Manufacturer’s technical representative certifying satisfactory installation, operation, and in-service placement of units.

1.07 QUALITY ASSURANCE

A. Standardization: All like equipment to be obtained from a single manufacturer.

B. The Contractor shall obtain washer compactors, gear reducers, motors and appurtenances from the washer compactor manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system. Contractor responsible for all details necessary to properly install, adjust, and place in operation complete working system.

C. Equipment specified shall be manufacturer’s standard cataloged product and modified to provide compliance with the drawings, specification and the service conditions specified and indicated.

D. Manufacturer of specified equipment shall have a minimum of twenty (20) year history of engineering and fabricating screenings washer compactors. Documentation of at least thirty (30) installations having been installed for a minimum of five (5) years shall be provided.

1.08 DELIVERY, STORAGE AND HANDLING

A. The washer compactor shall be shipped as a complete unit including the motor and inlet hopper, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

B. Deliver, unload and store products on site in manner that prevents damage. Use special care to prevent damage from temperature and condensation.

C. The Contractor shall store and temporarily support equipment prior to installation in strict accordance with the Manufacturer's recommendations and instructions. Protect all exposed surfaces. Keep records of the storage parameters and the dates that storage procedures were performed. The Contractor shall be responsible for work, equipment, and materials until inspected, tested and finally accepted.

1.09 – 1.11 (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURER(S)

A. Enviro-Care Company

B. Vulcan Industries, Inc.

C. Huber Technology, Inc.

2.02 MATERIALS AND/OR EQUIPMENT

A. General
   1. The shafted screw type screenings washer compactor shall be a complete assembly consisting of a transition chute between the screenings screw conveyor and screenings washer compactor inlet. The shafted screw washer compactor shall be designed to receive and reduce the organic content in screenings by means of sprayed wash water; then reduce the water content and volume through a pressing zone. After the compacting and dewatering process, the screenings shall be conveyed through the discharge transportation tube to the dumpster.
   2. Screenings washer compactors that use impellers and/or grinders to tear and shred fibrous screenings at the inlet to the compactor and therefore increase the amount of inert material returned to the plant shall not be allowed.
   3. Refer to and comply with the performance requirements specified in Attachment "A".
   4. The washer compactor shall be designed and built to withstand maximum possible forces exerted. All structural and functional parts shall be sized to prevent deflections or vibrations that may impair the washer compactor operations. All components of the washer compactor shall be made of type

304 stainless steel except the shaft screw which shall be from high strength steel with Hardox™ 400 flights throughout. Bearings, electrical devices, sprockets, motor and gear reducer shall be of the manufacturer's standard materials.

5. The washer compactor shall discharge screenings capable of passing the EPA Paint Filter Test as described in method 9095 of the EPA publication SW-486.

B. Screw Housing

1. The screw housing shall be constructed of type 304 stainless steel. The screw housing shall have support beams with U-profile on each side. The screw housing shall be designed to support all required loads.
2. The interior of the screw housing shall incorporate at least six (6) anti-rotation wear bars each fabricated from Hardox® 400 special high strength alloy steel with minimum Brinnel Hardness of 400. Welded guide bars are not acceptable.
3. The bottom of the housing shall be provided with perforated or wedge-wire drainage sections. Perforations shall be countersunk with maximum 1/4-inch in diameter. Wedge-wire shall have 2mm openings.
4. An inlet area length as specified in Attachment "A" will receive incoming materials. A hopper constructed from type 304 stainless steel shall be provided by the manufacturer to direct solids to the inlet area of the screenings washer compactor.

C. Shafted Screw

1. The screw will be constructed of high strength low alloy carbon steel and Hardox® 400 flights (minimum 400 Brinell), prime coated for protection during shipment. Screw OD shall be minimum 8.5-inch with minimum 0.47-inch thick flights welded to a minimum 2.5-inch diameter shaft. The final flight of the screw shall be supplied dual thickness 0.94-inch for increased wear life.
2. A replaceable nylon brush reinforced with a stainless steel backer shall be attached to the screw flights in the drainage area with stainless steel clips and hardware. To reduce wear on the brush the screw shall be cantilevered off the thrust bearing to prevent the screw from resting on the washer compactor housing.

D. Thrust Bearing

1. An independent thrust bearing housing shall be flanged mounted to the drive and flanged mounted to the washer compactor body. The independent thrust bearing assembly shall be protected from the environment and located in a separately sealed area located inside the washer compactor body. The flange portion of the thrust bearing shall have a grease fitting centrally located for ease of maintenance.
2. The thrust bearing shall fully support the screw and handle the load created during compaction and reversal of the screw. The thrust bearing shall utilize a self-aligning double tapered roller bearing complete with double lip grease seals and O-rings. The mounting flange shall have an O-ring seal mounted in a machined groove to seal the housing against the washer compactor body. Designs that utilize the thrust bearing inside the gear reducer housing will not be acceptable.

E. Drain Pan

1. A drain pan shall be mounted to the bottom of the screw housing along the full length of the housing. The pan shall be sloped to the drain and it shall be provided with a flushing water connection. Drain connection shall be minimum 3 inch plain ended pipe. Flush connection shall be minimum 1-inch NPT connection.
2. The pan shall be secured in place with hardware and allow for easy removal. Drain pan shall be constructed of minimum 14-gauge 304 stainless steel.

F. Wash Water Manifold
1. Manufacturer shall provide a valve manifold assembly with equipment.
2. The screenings washer shall be provided with a minimum of two (2) separate connections for injecting wash water into the screenings.
3. Wash water spray nozzles shall be capable of utilizing the screened plant effluent without clogging or fouling.
4. The wash zone shall include a spray wash system to wash organic residue from the screenings. The wash zone spray will consist of one (1) spray header with two (2) wash water injection points, two (2) brass spray nozzles, two (2) PRVs, one (1) ball valve and one (1) solenoid valve. The spray connection will be 1-inch NPT.

G. Inlet Hopper
1. The inlet hopper shall be designed to accept discharge screenings from the Screw Conveyor discharge chute. The hopper shall directly interface with the Screw Conveyor discharge chute with no solids or water bypass.
2. The inlet hopper shall be fabricated from minimum 12-gauge type 304 stainless steel.

H. Discharge Pipe
1. The discharge pipe shall be flanged and mounted to the washer compactor body by a minimum 8-inch diameter flange.
2. The discharge pipe shall be designed to transport the washed, dewatered, and compacted screenings to the discharge point without plugging.
3. The diameter of the straight section of the discharge pipe shall increase in size to ease the transportation of the screenings.
4. The discharge pipe elbows shall be fabricated from minimum 11-gauge type 304 stainless steel. The final elbow shall have a radius that is three times (3x) larger than the pipe diameter.
5. The discharge piping following the elbow shall be fabricated from minimum 12-gauge type 304 stainless steel.

I. Drive Assembly
1. The gear reducer shall be a flanged mounted directly to the thrust bearing housing and the compactor frame. Gear reducer shall be a helical gear type with hollow input shaft. The unit will be provided with a cast iron frame and be designed in accordance with AGMA recommendations for Class I service based on the horsepower required to operate the screen. Units that do not bolt the gear reducer directly to the unit's frame will not be allowed.
2. The motor shall be TEFC, 5.0 HP, 460 Volt, 3 phase, 60 Hz. The motor shall be NEMA design code B and be direct coupled to the reducer.
3. Chain drives, belt drives, and hydraulic drives will not be accepted.

J. Electrical Control and Devices

1. In addition to the drive motor, the equipment supplier shall furnish all electrical items specifically called for in this Specification section. The Contractor shall supply all other electrical items, and interconnecting wiring of proper size, including all conduit and supports required to place the equipment into service.
2. Main Control Panel
    a. Contractor to furnish and install a dedicated packaged control panel for the screenings washer compactor system. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include equipment controls, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings. Control panel shall be provided in accordance with Specification Section 13390, "Packaged Control Systems".
    b. Design: Factory-wired and tested control panel designed to function with equipment. For each individual item, control panel functions as defined on the Electrical and Instrumentation & Control Drawings.
    c. Panels materials and design to be specifically selected for durability and corrosion resistance, for unprotected installation outdoors in presence of intense sunlight and corrosive gases (hydrogen sulfide).
    d. Panel shall be designed to meet all NFPA 820 area classification requirements. The upper level of the Headworks is classified Class 1, Division 2. Panel shall be provided that satisfies all classification requirements.
3. Field Control Station
    a. Contractor to furnish and provide field control stations for each item of equipment as defined on the Electrical and Instrumentation & Control Drawings.
    b. Field control station shall be per Specification Section 16540, "Field Control Stations".
4. Solenoid Valve: A minimum of one (1) solenoid valve shall be provided to control flow to the spray wash assembly. The brass body valve shall be 120 Volt, single phase, 60 Hz with a NEMA 4X housing.

2.03 OPERATION

A. Sequence of Operation for the washer compactor is operated based on the run time of the associated screens and/or screenings conveyor. The control panel for the washer compactor shall receive a signal from the screen and/or screenings conveyor panel when in operation and accumulate the time the screen is in operation. The washer compactor starts the wash cycle when the accumulated screen and/or screenings conveyor operation time reaches the set point.

B. HAND OPERATION: When HAND mode is selected, the spiral will run continuously. When spray wash HAND mode is selected, the spray wash will run continuously.

C. INTERMITTENT AUTOMATIC OPERATION: The control panel will be equipped to control the wash cycle and screw movement. The wash cycle and the screw movement will be controlled independently by means of timers and counters. The drive motor and spray wash will be controlled automatically when the selector switches are placed in the Auto position.
    1. The press motor starts after an adjustable accumulated run time from the interlocked feeding equipment.

2. The wash water solenoid is open whenever the screw is in operation.
3. The washing solenoid closes and the press motor runs for an adjustable length of time, typically set at 30 seconds, to dewater and discharge the screenings.

D. EMERGENCY STOP: The unit can be deactivated at any time by pressing either the control panel mounted or unit mounted Emergency Stop push buttons.

E. FAULT CONDITIONS: Motor overload, high motor torque, or high motor current conditions will stop the motor and illuminate the fault light.

2.04 ANCHORAGE AND FASTENERS

A. Anchor Bolts: All anchor bolts shall be made of type 304 stainless steel. The equipment supplier shall furnish all anchor bolts, nuts, and washers required for the equipment.

B. Fasteners: All fasteners shall be type 304 stainless steel. The equipment supplier shall furnish all fasteners required for the assembly of the equipment.

2.05 FABRICATION

A. Shop Painting and Coating
1. Per Specification Section 09960, “High Performance Coatings”.
2. Stainless steel and plastic components shall not be coated. The stainless steel structural components shall be passivated per the methods described in ASTM A380-99, after fabrication to remove embedded iron, surface rust and weld burn.
3. All other surfaces shall be solvent cleaned to remove dirt, oil and foreign materials. Cleaned surfaces shall be coated with one (1) coat of TNEMEC Series N69-1212 primer, or equal, to attain a minimum dry film thickness of 3-5 mils. The motor and gear reducer shall be finish coated with one (1) coat TNEMEC Series 1074 Endura-Shield, or equal, to attain a total minimum dry mil thickness of 3-5 mils. The finish coat shall be red in color and semi-gloss in finish.
4. Non-stainless steel control panels shall have Manufacturer’s standard paint finish.
5. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.06 SPARE PARTS

A. The Manufacturer shall furnish the following spare parts as the total amount of spare parts for this specification section.
1. One (1) solenoid valve
2. Two (2) sets of wear bars and attachment hardware (if applicable).
3. One (1) cleaning brush

B. All spare parts shall be properly packaged, labeled and stored where directed by the Owner or Engineer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. The manufacturer shall furnish the anchor bolts for the equipment. It is the Contractors responsibility to install the anchor bolts in accordance with the manufacturer's recommendations.

B. The Contractor shall be responsible to verify the accuracy of all dimensions in the field and to ensure compatibility with the specifications and equipment.

3.02 TESTING

A. The washer compactor shall be factory assembled and factory run tested. The main control shall also be factory tested. If the washer compactor is manufactured outside of the United States, the washer compactor shall be factory tested at the point of manufacture and factory tested a second time as a complete assembly (including the motor and control panel) in the United States prior to shipment to the jobsite.

B. The washer compactor shall also be field tested after erection in the presence of the Owner and Engineer to confirm and verify the structural and mechanical compliance to the specification. The field acceptance test shall include demonstrating that the washer compactor operates without vibration, jamming or overheating and perform its specified function satisfactorily.

3.03 START UP/TRAINING/FIELD QUALITY CONTROL

A. The manufacturer shall furnish the services of a factory-trained service technician to inspect the installation, observe start up, and provide operator training.
   1. The equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the service technician present.
   2. The service technician shall perform all necessary adjustments and settings to the controls. In particular, the service technician shall verify the measurement relay setting.
   3. The Service technician shall demonstrate the proper screenings washer sequence of operation. The screenings washer shall be set up to initiate after a successive number of screen cycles (accumulated runtime), as determined by the service technician.

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

SCREEENINGS WASHER COMPACTOR SCHEDULE

Parameters	Requirements
Number of Washer Compactors	1
Influent Type	Municipal Wet Screenings
Minimum Inlet Solids Capacity	99 ft^3/hr
Inlet Length	31.5 inches
Volume Reduction	60 – 85%
Weight Reduction	60 – 85%
Discharged Material Dry Solids	>35%
Washed Screenings Fecal Reduction	90% (<20 mg/g BOD5)
Spray Wash Water Flow Rate	Minimum 16 gpm
Spray Wash Water Pressure	20 – 40 psi
Motor HP	5.0
Power Supply (V/P/Hz)	460/3/60
Wash Press NFPA Classification	Class 1 Division 2
Control Panel NFPA Classification	Class 1 Division 2

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SECTION 11353

CIRCULAR SECONDARY CLARIFIER EQUIPMENT COLUMN SUPPORTED, SPIRAL BLADE TYPE

PART 1 GENERAL

1.01 SUMMARY

A. Furnish, install, test, and place in-service complete spiral scraper-type sludge collector mechanisms and accessories in circular concrete basins as shown on PLANS and as specified herein.

B. Each mechanism shall be a center column supported, center feed unit with peripheral effluent collection.

C. Test scraper-type sludge collector mechanisms, gear reducers, motors, controls and appurtenances as indicated and in compliance with Contract Documents.

1.02 RELATED REQUIREMENTS

A. PLANS show general arrangement, location, and basic dimensions. Attachment “A” to this Specification Section gives performance and design requirements.

B. Related work as called for on PLANS or specified in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

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

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	Load Ratings and Fatigue Life for Ball Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908-B	Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
AGMA 2001-C	Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
AGMA 2004-B	Gear Materials and Heat Treatment Manual
AGMA 6034-B	Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gear Motors

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

M016 Manual of Steel Construction Allowable Stress Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A36 Standard Specification for Structural Steel

ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A276 Standard for Stainless Steel Bars and Shapes

ASTM A351 Standard Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure Containing Parts

ASTM A666 Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1 Structural Welding Code - Stainless Steel

AWS D1.1 Structural Welding Code - Steel

1.04 SUBMITTALS

A. Submit in accordance with Specifications Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”.
   1. Certified shop and erection drawings showing important details of construction including dimensions, anchor bolt locations, and field connections. General arrangement drawings, plan and section showing collection mechanism, scum box, bridge, drive unit, piping, supports and all process equipment interfaces. Furnish project-specific layout drawings of equipment, piping, conduit, controls, etc. wherever the PLANS are diagrammatic in nature or equipment to be provided differs from that indicated on PLANS. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified.
   2. Descriptive literature, bulletins, and catalogs of the equipment, including details of the motor, gear reducer, and lubrication points.
   3. Drawings showing materials of construction, thicknesses, operating and maintenance envelope and assembly weight.
   4. Structural design calculations sealed by a Texas Professional Engineer confirming design meets all loading conditions specified in this Specification.
   5. Complete sludge transport calculations substantiating the rake blade design, rake tip speed, and floor slope.
   6. Complete process calculations substantiating the sizing of the center column and ports, EDI and outlets, and outer feedwell. These calculations shall be based on parameters from the manufacturers operating experience. These parameters shall be verified by data presented from successful operating installations. Side by side comparison testing of EDI and feedwell design from existing operating clarifiers that have spiral rake blades and are products of the manufacturer shall be presented with the calculations.
   7. Calculations showing withdrawal rates and headlosses of the sludge withdrawal ring.

8. Installation, operation, and start-up procedures, including manufacturer's recommended procedures for pre-installation jobsite storage and handling. Equipment weight and lifting points for installation and removal purposes.
9. Motor manufacturer's data sheets and drawings. Motor shop test results.
10. Schematic control and power wiring diagrams including interconnecting and internal wiring diagrams.
11. Control panel drawings.
12. Cathodic Protection calculations and design details as specified in Paragraph 2.03.M.2.

B. Furnish in accordance with Specification Section 01730:
1. Operating and maintenance instructions and parts lists. A list of recommended spare parts other than those specified. Predicted life of parts subject to wear.

C. Certificate of conformance as required in Paragraph 1.05 – Quality Assurance.

D. Field testing procedure, calibration certificates for all testing equipment, and pre-testing checklist as required in Paragraph 3.03 – Field Testing.

E. Installation Report:
1. Furnish copies of certified report prepared by Manufacturer's technical representative certifying satisfactory installation, operation, and in service placement of units.

1.05 QUALITY ASSURANCE

A. Comply with the requirements specified in Specification Section 01400, "Quality Control Services".

B. Standardization: Sludge collector equipment shall be the product of a single manufacturer.

C. System Coordination: CONTRACTOR is responsible for all details necessary to properly install, adjust, and place in operation a working system.

D. All design computations and detail drawings are to be prepared by or under the direct supervision of a Professional Engineer registered in the State of Texas. Provide certificate signed and sealed by same engineer stating that the computations and drawings are in conformance with design criteria.

E. Equipment specified shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

F. The Manufacturer shall have at least 15 years experience in the design, application, and supply of circular clarifiers and shall have a minimum of ten (10) operating installations with spiral rake blades and EDI equipment of the size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING

A. Shipping

1. Ship factory fabricated assemblies in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.
2. Loose parts (couplings, nuts and bolts, gaskets, etc.) are to be shipped in crates that are clearly marked as to contents.

B. Handling and Unloading
1. Unload and handle equipment in accordance with manufacturer's instructions. Handle unit to prevent damage during unloading and installation. Follow manufacturer's instructions on lifting and setting.

C. Storage
1. Store in an area that will avoid damage due to traffic. Store and temporarily support equipment prior to installation in strict accordance with the manufacturer's recommendations and instructions.
2. Exposure to normal weather conditions is acceptable; however, avoid contact with other materials like aluminum, concrete, and corrosive chemicals.
3. Store at job site on 4"×4" blocking at 6-foot spacing. Protect from corrosion and mechanical damage.
4. Store gear reducers and motors in buildings or trailers which have a concrete or wooden floor, a roof and fully closed walls on all sides. Protect the equipment from being contaminated by dust, dirt, vibration and moisture.
5. Connect space heaters to a power source and keep heaters in operation. Rotate all shafts that have bearings on at least a monthly basis.

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE REQUIREMENTS

A. General: Provide a complete, integrated set of mutually dependent components and assemblies that form a center-pier supported sludge collector mechanism capable of withstanding structural and other loads without failure.

B. Sludge Collector Mechanism Materials: All components of the collector mechanism, access bridge and pipe/conduit supports are to be constructed of hot-dipped galvanized fabricated structural steel, ASTM A36/A36M. Miscellaneous items (scum box, scum baffle, and weir) are to be Type 304L stainless steel.

C. Structural Criteria: Provide sludge collector mechanism capable of withstanding the effects of gravity loads and live loads within limits and under conditions indicated:
1. Half Diameter Access Bridge: Design bridge to span from tank wall to center drive platform. Design to be in accordance with the latest edition of the Uniform Building Code. Include vertical loads induced by maintenance workers, materials and equipment for access bridge live loads. Maximum allowable deflection of the bridge to be 1/360 of the span under uniform live load of 100 psf, in addition to the dead load. Bearing on support walls to be 8 inches. Bridge walkway elevation to be as shown on the PLANS. If structural design requires deeper sections than allowed for, or increased wall height at bridge support location, provide beam pockets or increased wall height and coordinate any structural concrete changes. Structural concrete changes to be at no additional cost to OWNER.
2. Pipe/Conduit Supports: Supports to be capable of withstanding the loads induced by piping, water, electrical conduit, and conductors, size and materials

as shown on the PLANS. Supports to be spaced every 5-feet for pipe/conduit less than 2 inches. Supports for pipe/conduit 2-inches and greater to be spaced every 10 feet.

3. Center Pier: Center column to support the complete sludge collector mechanism and the center of the access bridge. Center column to withstand the full torque developed by the mechanism, with none transferred to the bridge.
4. Scum Box Support: Support load of scum box filled with water with the basin empty, with a minimum safety factor of 1.5.
5. Structural Members: Structural members to be based on the design criteria, but not less than 1/4-inch. Structural members to meet all AISC Specifications at twice the continuous operating torque.
6. Fabricated structural steel to comply with AISC Standards. Welding to comply with AWS Standards.
7. Collateral Loads: Include additional dead loads, other than the weight of the metal collector mechanism, for permanent items such as electrical and mechanical systems.
8. Load Combinations: Design sludge collector equipment to withstand the most critical effects of load factors and load combinations. Center column, drive mechanism, drive cage, and rake arm shall be designed to allow operation without damage up to shear pin failure point at 140% of design torque, without reduction in design safety factor.
9. Provide support plates welded to the bridge structure to support light standards at locations shown on PLANS. Design for a minimum moment of 1,200 ft-lbs.

D. Hydraulic Criteria: Outlet ports in influent column to be of sufficient area that, when modeled as an orifice, does not create a head in excess of the column pipe discharging freely.

2.02 MANUFACTURERS

A. Subject to compliance with the requirements of this Section, the following manufacturers have the capability of performing the work in this Section:
   1. WesTech
   2. Ovivo
   3. Walker Process
   4. Or Owner/Engineer approved equal

2.03 MATERIALS AND/OR EQUIPMENT

A. General:
   1. Sludge collector mechanism to be centerpier supported, center drive type, with bottom center feed and peripheral overflow.
   2. No drive components to be below water surface.
   3. Furnish complete collector mechanism, including a center drive unit, drive control with overload protection, stationary influent column, energy dissipating inlet (EDI), flocculating feedwell, center cage, sludge removal arms with spiral blades and squeegees, full surface scum skimmer and scum box, access bridge from tank wall to center drive platform (half diameter), drive platform, weir plates, scum baffles, anchor bolts, and other appurtenances as shown in PLANS and outlined in Attachment “A” to this Section.

4. All collector mechanism components to be hot-dipped galvanized fabricated structural steel and have a minimum thickness of 1/4-inch, unless other material is shown in PLANS or specified herein. Type 316 stainless steel anchor bolts and fasteners, with necessary hex nuts and washers, to be provided for all parts of the collector mechanism. All anchor bolts set in concrete to be Type 316 stainless steel at least 3/4-inch in diameter. All others to be a minimum 5/8" diameter and be Type 316 stainless steel.
5. Units to be factory fitted before shipment. No burning of holes is allowed. Holes may be reamed or drilled in field as required.
6. Provide gaskets or bushings to isolate dissimilar metals.

B. Drive Unit
   1. General:
      a. The continuous torque rating of the spur gear assembly to be based on the smaller of the values developed by AGMA Standards 908-B or 2001 C and is to be considered as the continuous rated torque capacity the entire gear will develop continuously 24 hours/day (7 days/week) over a 20-year period.
      b. The drive unit to be designed in compliance with the most recent version of the following standards:
         1) ABMA, Standard Practice, L_{10} Life, Bearings.
         2) AGMA 908-B.
         3) AGMA 2001-B.
         4) AGMA 2004-B.
         5) AGMA 6034-B.
      c. Drive assembly to be designed so that the internal gear, ball bearings, and bearing race liners may be removed and replaced.
      d. All gear reducer bearings to be antifriction type and oil-lubricated.
      e. Provide lubrication system with oil fittings as required. Lubrication fittings to be readily accessible.
      f. Provide oil seals as required.
      g. Access Cover: Furnish unit with an aluminum (6061 T6) checkered plate for access to drive oil fill/drain connections.
   2. Primary Speed Reduction Unit
      a. Primary speed reduction unit to consist of a motor and cycloidal or helical gear type speed reducer mounted on a cast iron drive base.
      b. Connect primary speed reducer to secondary reduction unit with a standard steel roller chain and steel sprockets. Drive chain to be self-lubricating.
      c. Provide OSHA approved Type 304 stainless steel or polyethylene chain guard.
   3. Secondary Speed Reduction Unit
      a. Wormgear shafts to be supported by antifriction bearings and the output shaft to directly drive the pinion gear of the final speed main bearing assembly.
      b. The worm gear speed reducer to consist of a carburized, hardened, ground alloy steel worm and a centrifugally cast bronze or meehanite worm gear, all within a cast iron gear case.
      c. Gear to be keyed to the spur gear pinion shaft that drives the internal gear of the final speed reduction unit. The pinion to be manufactured from heat-treated alloy forged steel with machined teeth.
   4. Final Speed Reduction Unit

a. The main internal spur gear to run on a ball bearing support assembly. Bearings to be high carbon chrome alloy steel with a L_{10} life rating of not less than 100,000 hours. Bearings to run in an oil bath on replaceable hardened alloy steel race liners pressed into annular raceways in the gear turntable base.
b. Internal gear to be ductile iron.
c. The gear housing to be cast iron or steel and to have felt dust shields.

5. Motor: NEMA Design B, totally enclosed for outdoor service, mounted on reduction unit. Size to operate without overloading under all operating conditions. Power supply per Attachment "A".
6. Overload Protection System
   a. Provide the drive unit with an overload protection system enclosed in a weatherproof housing. System to have a visual overload indicator plainly showing the overload points. Protect visual indicator from atmosphere by installing in a plastic enclosure with a plexiglass window to view setpoints.
   b. The overload alarm and shut-off system to consist of two microswitches. The microswitches to be activated by the movement of the worm shaft in the worm gear housing. Microswitches to be adjusted as follows:
      1) One switch set at 100 percent of the continuous operating torque.
      2) Second switch set at 120 percent of the continuous operating torque.
   c. Provide a shear pin assembly to serve as back-up overload protection set to fail at 140 percent of continuous operating torque.

C. Stationary Influent Column:
1. Design cylindrical steel center column to serve as an influent pipe and to support the complete sludge collector mechanism and one end of the access bridge.
2. The center column shall be fabricated of not less than 1/4" thick steel plate suitably reinforced where necessary. One end shall have a support flange for bolting to the tank floor over the influent line, with a similar flange at the top for supporting the drive unit and walkway.
3. Design center column to take full torque developed by mechanism with none transferred to access bridge.
4. Provide outlet ports to minimize turbulence in influent feedwell. Influent velocity shall be reduced by providing a total inlet port area a minimum of 135 percent of the center column cross sectional area.

D. Flocculating Feedwell:
1. The flocculating feedwell shall be located outside of the energy dissipating inlet (EDI) to diffuse the liquid into the tank without disturbance or formation of velocity currents. Baffled openings shall be provided near the water surface to allow scum to exit the feedwell.
2. The supports for the feedwell shall be located either above the liquid extending from the cage of bridge, or on the rake arms. Submerged supports from the rake arms shall be designed so as to minimize horizontal flow disruption.
3. No feedwell support or feedwell spliced connection shall be contained within the annular space formed between the feedwell and the EDI. The depth of the feedwell shall be such as to provide proper detention time and an exit velocity at maximum flow that will not scour the settled sludge. The diameter, depth, detention time, and exit velocities shall match the process application calculations as evidenced by the required successful operating installations.

4. The feedwell shall be made of not less than 1/4-inch thick steel plate with necessary stiffening angles.
5. Size the flocculating feedwell per Attachment “A”.

E. Energy Dissipating Inlet (EDI)
1. The clarifier shall be equipped with an energy dissipating inlet (EDI) located inside the rotating feedwell. The dissipating inlet shall be designed to dissipate the energy of the incoming flow thereby inducing flocculation of the feed solids.
2. The EDI shall have a bottom plate extending to within 1 inch of the center column and may be provided with drain holes as required to prevent sludge from collecting with the EDI. The well shall be constructed of 1/4-inch thick steel plate. Baffled openings equally spaced around the periphery shall be provided.
3. Multiple discharge ports shall be provided to induce tangential flow. The EDI shall have a fixed bottom to prevent vertical currents as the flow exits the EDI.

F. Center Cage
1. The center cage to be of steel box truss construction designed to support and rotate the sludge collector arms, and feedwell.
2. The cage top to be bolted to the main gear which shall rotate the cage with the attached arms and feedwell.
3. The center cage to be fabricated from a minimum of 1/4-inch thick rolled structural angles or sections of standard shapes only.

G. Sludge Scraper Arms
1. The mechanism shall include two long sludge rake arms of steel truss construction with spiral shaped steel scraper blades and vertically adjustable stainless steel squeegees. Squeegees shall be fastened to the rake blades with stainless steel fasteners. Squeegee clearance tolerance shall be ¼-inch minimum and ¾-inch maximum from the grouted floor of the clarifier.
2. The sludge scraper arms to be welded truss-type construction requiring no tie rods for support.
3. Scraper blades shall be designed for sufficient sludge transport capacity to handle the design solids loading rate, with the depth of the blade varying from a minimum at the tank periphery to a maximum at the tank center. Minimum spiral scraper depth at tank perimeter wall and near tank center to be as noted in Attachment “A”.
4. The spiral scraper blades shall have an angle of attack of 30 degrees and positioned to effectively transport sludge to a centrally located hopper.
5. The arms shall be adjustable at the cage.
6. The collector arms shall be fabricated from rolled structural angles or sections having a minimum thickness of 1/4-inch and designed to meet AISC specifications when twice the continuous torque of the drive unit is applied as a uniform load to both arms.
7. Tip speed of sludge collector arms to be as noted in Attachment “A”.

H. Skimmer
1. Two, tangential surface skimmer arms to be arranged to sweep the entire surface of the settling portion of the basin, removing scum and floating material into a scum box at basin periphery.

2. Support skimmer with structural steel members fixed to each sludge scraper arm. The scum baffle is not to be used for skimmer support.
3. Skimmer blade to maintain contact with the scum baffle as it travels around the basin. Skimmer blade to be hinged to ride up and over scum trough and have an adjustable and replaceable neoprene wiper. The skimmer blade to be designed to gently return to the basin after riding up and over the scum trough.

I. Scum Box
1. Support scum box from wall using cast-in-place anchor bolts.
2. Scum box width is defined in Attachment "A" and is to be made of 1/4-inch (minimum) thick Type 304 stainless steel plate, to serve as an integral portion of the inside scum baffle. Scum box to be adequately reinforced to prevent excessive deflection.
3. Assembly to consist of a sloping approach ramp and scum trough with vertical steel sides and discharge pipe sized as shown on PLANS. The sloping approach ramp to extend to 1½" above the maximum water surface, to 5½" below the minimum water surface.
4. The scum trough to span the entire width of the scum box, and be 1-foot wide and a minimum of 1-foot deep. Slope trough to discharge pipe.

J. Scum Flushing Valve
1. The clarifier equipment manufacturer shall furnish a flush valve assembly for automatic flushing of the scum trough and scum pipe.
2. The flush valve assembly shall allow approximately 2 to 5 gallons of clarified effluent to enter the trough as the skimmer assembly passes over the scum trough.
3. The flush valve assembly shall consist of an actuator bar and a pivoting assembly that will open a valve. A counterweight shall close the valve after the flush cycle ends.

K. Center Drive Platform and Access Bridge
1. Provide an access bridge from clarifier basin wall to center drive platform (half diameter). Bridge to be either truss or beam type construction with a minimum of 3-foot clear width for access. For truss type construction, the truss sides to serve as handrails for the bridge. For beam type construction, provide three rail-type handrail with toe plate, per applicable section. Bridge walkway to be provided with galvanized-steel grating attached to the main support members with stainless steel clips.
2. The access bridge shall be designed to safely withstand a live load of 100 pounds per square foot. Deflection shall not exceed L/360 when both the dead load and live loads are applied.
3. Center drive platform to be of sufficient size to allow a minimum of 2'-6" clearance between all sides of the drive unit and the handrails. Access bridge is not to have step-down on center column. Provide three rail-type handrail with toe plate around center drive platform per applicable Section.
4. Bridge/center drive platform assembly to be fabricated from carbon steel and hot-dipped galvanized after fabrication.
5. Provide supports for water piping and electrical conduit per the design criteria. Piping/conduit located as shown on the PLANS.

L. Weir Plates and Scum Baffles

1. Weir plates to be fabricated from 10 gauge AISI Type 304L stainless steel. Weir plates to be furnished with 3/8-inch full-face, neoprene soft sponge rubber gaskets.
2. The weir sections shall be curved and fastened to the launder wall with special large washers, anchor bolts, and hex nuts to allow vertical adjustment.
3. Scum baffles to be fabricated from 3/16-inch (minimum) thick AISI Type 304L stainless steel. All associated appurtenances and anchor bolts for weir plates and scum baffles to be Type 316 stainless steel. Splice plate connectors to be constructed in a manner that will not interfere with smooth contact of the skimmer.
4. In the area of the scum box, the baffle shall extend 24 inches deep starting approximately 6-feet preceding and ending 6-feet following the scum box.
5. The baffle sections shall be curved and fastened to the launder wall with adjustable support brackets, stainless steel fasteners, and anchor bolts.
6. See PLANS for dimensions and configuration of V-notch weir.

M. Accessories
1. Bridge Lighting Support
    a. Provide supports for lighting standards and fixtures as indicated on the PLANS.
    b. Supports to be galvanized steel and welded to access bridge in the locations shown on the PLANS.
    c. Supports base to be 3/8-inch thick plate, 14-inches wide. Plate to extend 10-inches from closest bridge appurtenance.
2. Passive Cathodic Protection System
    a. Furnish and install passive cathodic protection system for each proposed clarifier mechanism as a secondary cathodic protection method, additional to the hot dipped galvanized coating to be furnished for all collector drive mechanism structural components.
    b. Clarifier equipment manufacturer to approve proposed anode mounting locations, weights and mounting/connective methods. Anode installation design shall not result in voided or reduced warranty, reduced structural safety factor, or decreased torque rating for the clarifier equipment.
    c. Submit the following material for Engineer review:
        1) Design calculations for cathodic protection to provide specified service life. Additional protection provided by hot dip galvanized coating shall not be counted toward required service life. Design shall be based on typical or measured conductivity in WWTP mixed liquor and shall account for surface area to be protected; current required; anode potential; anode in-situ current output; and design service life. Cathodic protection design is to be based on protection of submerged or partially submerged carbon steel components only (not required for ductile iron, stainless steel or other metal items).
        2) Plan and section layout drawings indicating anode locations on clarifier equipment, shown to scale.
        3) Details for attachment and galvanic connection.
        4) System components descriptions/specifications/bill of materials.
        5) Written confirmation by clarifier manufacturer of approval of proposed anode locations, weights, and attachment/connection methods.
    d. System Description and Design Requirements:
        1) Design Protective Service Life: 10 years (minimum)
        2) Type: Passive, using direct-mounted bare magnesium/alloy anodes

3) Anodes: Quantity 40 x 20 lbs each (minimum), or equivalent protection as justified by final cathodic protection design
4) Locations: Anodes to be distributed as required for protection of:
   a) Sludge collector rake arms components
   b) Drive cage components
   c) Energy dissipating inlet and support members
   d) Flocculating feedwell and support members
   e) Scum boxes and support members
5) Mounting: Installed on electrode brackets bolted to structure
6) Connectivity: Welded and/or bolted galvanic connections, as approved by clarifier mechanism manufacturer.
7) Any incidental damage to hot dip galvanized coatings during anode installation shall be repaired by application of zinc-rich coatings and repair compounds conforming to requirements of Federal Specification DOD P-21035A and/or in accordance with clarifier equipment manufacturer's recommendations.
8) Cathodic protection system to be as furnished by:
   a) CorrPro, Medina OH
   b) Matcor, Inc., Chalfont PA
   c) Alternate supplier approved by clarifier equipment manufacturer

N. Controls
   1. Main Control Panel
      a. Contractor to furnish and install a dedicated packaged control panel for each clarifier. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include equipment controls, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings. Control panel shall be provided in accordance with Specification Section 13390, "Packaged Control Systems".
      b. Design: Factory-wired and tested control panel designed to function with equipment. For each individual item, control panel functions as defined on the Electrical and Instrumentation & Control Drawings.
      c. Panels materials and design to be specifically selected for durability and corrosion resistance, for unprotected installation outdoors in presence of intense sunlight and corrosive gases (hydrogen sulfide).
      d. Panel shall be designed to meet all NFPA 820 area classification requirements. Panel shall be provided that satisfies all classification requirements.
   2. Field Control Station
      a. Contractor to furnish and provide field control stations for each item of equipment as defined on the Electrical and Instrumentation & Control Drawings.
      b. Field control station shall be per Specification Section 16540, "Field Control Stations".

2.04 FABRICATION

A. Stainless steel and hot-dipped galvanized components are not to be painted.

B. Coat all machined steel and iron components with a rust-preventive compound.

C. Galvanize rolled, pressed, or forged steel shapes, plates, pipe and bars per ASTM A123 after completion of welded fabrication. Provide a minimum thickness of 4.2 mils of zinc.

D. All steel to be primed and finished in accordance with Specification Section 09960, “High Performance Coatings.”

E. Stainless steel fabrication to be per Specifications.

2.05 SOURCE QUALITY CONTROL

A. Welding
   1. All welding is to be performed by AWS qualified welders.
   2. Stainless steel assemblies are to be fabricated utilizing inert gas, shielded arc plasma, MIG or TIG welding procedures.
   3. Add filler wire to all welds to provide a cross-sectional area of weld and metal thickness equal to or greater than the parent metal. Filler wire to be at least one grade higher than the parent metal and of the extra low carbon grade.
   4. Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of joint. Weld beads to be smooth, with a projection not exceeding 1/16-inch.
   5. Rigid jigs and fixtures are to be utilized for holding parts together in proper alignment while welding.
   6. Weld concavity and undercut are not acceptable on either side of the weld.
   7. All joints are to be accurately fitted, aligned, and cleaned of foreign material prior to welding.

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Install equipment as indicated on the PLANS and in compliance with manufacturer’s instructions and shop drawings. Adjust weir plates for uniform overflow. Adjust scraper blades and squeegees to contour of basin floor to tolerances specified.

B. Install gaskets to isolate dissimilar metals.

C. Place grout fill to level floor of basin as shown on the PLANS. Electric motor on drive, scraper arms, and squeegees are not to be used for placing grout.

3.02 REPAIR/RESTORATION

A. Repair chipped or otherwise damaged galvanized areas by application of zinc-rich coatings and repair compounds conforming to requirements of Federal Specification DOD P-21035A in accordance with manufacturer’s recommendations.

3.03 FIELD TESTING

A. Testing and Placing in Service
   1. All final adjustments of equipment, controls, and instruments to be performed with assistance from technicians representing equipment manufacturer.

2. Coordinate start-up with other phases of construction for project. Instruct operating personnel concerning operating and maintenance procedures.
3. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, and a completed and signed pre-testing check list.

B. Operational Test:
1. Prior to acceptance, each mechanism to be subjected to an operational test, under the observation of the ENGINEER, to determine if the installed equipment complies with the TECHNICAL SPECIFICATIONS. Test to demonstrate that the equipment is not defective and is in safe and satisfactory operating condition.
2. The Contractor shall operate the mechanism in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures.
3. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4 hour observation test run.

C. Torque Test
1. General: After erection and prior to acceptance, each collector mechanism to be subjected to torque tests to verify structural and mechanical suitability of unit under design conditions and to verify the operation of the Overload Protection System. Torque test to be conducted under the observation of the OWNER and ENGINEER. Notify OWNER and ENGINEER at least 48 hours prior to initiating testing.
2. The following torque loads to be applied to the mechanism, as described in Paragraph 1 above:
    a. Apply to one flight arm 120% of the rated continuous torque.
    b. Apply to both flight arms 140% of the rated continuous torque by applying 70% of each arm simultaneously.
3. Complete test procedure to be submitted to the OWNER for approval prior to testing. Testing to be accomplished with the machine in operation. Loads to be applied at the intersection of the last diagonal to the bottom cord of the truss, forming one flight arm. Loads to be applied through chains or cables connected to a dynamometer, which in turn is connected to an anchor plate tied to the basin floor. An accurate measurement of the distance from the centerline of the unit to the point of load application to be taken to calculate the torque.
4. For each test, the mechanism to be started with a minimum of 3’-0” of slack in the tie-down cable or chain and then operated until the specified torque level is reached.
5. Any equipment that breaks or fails during the test to immediately be repaired by the CONTRACTOR, at no expense to the OWNER, and the test repeated until approved by the OWNER or ENGINEER.
6. All labor, materials, and test apparatus necessary for conducting the above tests to be furnished by the CONTRACTOR at no additional cost to the OWNER.

D. Manufacturer’s Services
1. Manufacturer’s technical representative to assist in the following services:
    a. Checking installation of units.
    b. Testing and adjustment of clarifier drive mechanism.

c. Instruction of OWNER's personnel in the operation and maintenance of clarifier units.

E. Make all adjustments necessary to place equipment in specified working order at time of above tests.

3.04 CLEANING

A. Visible rust spots on stainless steel assemblies are to be cleaned with stainless steel wire brushes and sprayed with "Eucleen" by Eutectic Company, or equal. Cleaning agent to be completely removed from surface after use.

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

A. Performance

Parameter	
Number of Units	2
Nominal Basin Dimensions	60 ft. diameter × 15.17 ft. SWD
Design Flow Per Unit (1)	0.75 MGD
Peak Flow Per Unit (1)	3.0 MGD
Mechanism Rotation	Clockwise
Max. Allowable Head Loss Thru Center Column at Peak Flow Per Unit	5 inches
Maximum Continuous Torque Rating	16,000 ft.-lbs.
Momentary Peak Torque	68,000 ft -lbs
Minimum Ball Race Diameter	35-inch
Center Pier Diameter	24-inch (min.)
Minimum Flocculation Feed Well Size	20.0-ft. diameter × 8-ft. deep
Minimum Energy Dissipating Inlet (EDI) Well Size	9-ft. diameter × 4-ft. deep
Minimum Bottom Slope	1:12
Minimum Scum Box Width	3-feet
Minimum Scum Box Length	5-feet
Minimum Tip Speed	10 fpm
Spiral Blade minimum height - tank center	18-inch
Spiral Blade minimum height - tank wall	6-inch

(1) Return flows not included.

B. Motor Requirements
   1. Minimum horsepower: 0.75
   2. Minimum service factor: 1.15
   3. Speed: 1800 rpm (max)
   4. Voltage: 460V, 3-phase, 60 Hz
   5. Enclosure: TEFC
   6. Construction and other features per Section 16222, "Electric Motors, Induction, 600 Volts and Below".

C. Scum Spray System
   1. General: Furnish and install scum spray system to direct scum toward scum collection box as skimmer arm approaches scum collection box. Each spray system to consist of spray nozzles, spray header, support system, pressure regulating valve and isolation valves.
   2. Spray headers to be sized as shown on PLANS and supported from access bridge. Fittings on scum spray to be ductile iron, malleable iron, or forged steel. Cast iron is not acceptable. Locate scum box and spray header to allow easy access to scum box trough from walkways and proper scum collection system performance.
   3. Operating Parameters:

a. Spray supply source: Non-potable water system.
b. Available supply pressure (downstream of Pressure Reduction Valve): 40 psig.

4. Spray Nozzles:
   a. Spray nozzles to be manufactured by Spraying Systems Co., or equal.
   b. Construction: Nozzle designed to minimize clogging.
   c. Material: Type 316 stainless steel.
   d. Spray nozzles to provide a minimum of 1.1 gpm/linear foot.
   e. Provide supports from clarifier walkway at a maximum of 2'-6" spacing. Provide spray nozzle assemblies evenly between the scum trough and the feedwell. Start spacing as shown on PLANS. Spacing to be adjusted so that half of the tank surface is sprayed with a minimum of 25% spray pattern overlap.
   f. Nozzles to be installed in spray header in such a manner that the spray impacts the water surface at a minimum 15° angle from the horizontal.
   g. Nozzles to be mounted above the maximum water surface at an elevation that clears all moving parts of the mechanism.

END OF SECTION

SECTION 11355A

VOLUTE THICKENER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Volute thickener complete with auxiliary equipment, control panels, and appurtenances to thicken Waste Activated Sludge (WAS).

B. Volute thickener and accompanying appurtenances are skid mounted and being provided by the owner. It is the Contractor's responsibility to transport the equipment from the Walnut Creek Wastewater Treatment Plant – 7113 FM 969, Austin, Texas – to the project site for installation. Installation, functional testing, process optimization, and training requirements included in this section are to be provided by the Contractor.

C. The following pieces of equipment are mounted on the thickener skid:
   1. Volute thickener: PWTech model VT-303.
   2. Polymer preparation system: VeloDyne Model VeloBlend VM-5P-600-X0D.
   3. TWAS pump: Seepex model BTQ 35-6LS.
   4. Influent sludge flowmeter: Rosemount™ Model 8750W with 6" ANSI flange connections.
   5. Two actuated valves.
   6. Control panel with shade.
   7. Associated piping and fittings.

D. Refer to Drawings for additional information on piping or fittings to be provided by contractor.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society for Testing and Materials (ASTM):
   1. A 36 - Specification for Structural Steel.
   2. A 48 - Specification for Gray Iron Castings.
   3. A 240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   4. A 276 - Specification for Stainless Steel Bars and Shapes.
   5. A 320 - Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for Low-Temperature Service.
   6. A 380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless-Steel Parts, Equipment, and Systems.
   7. A 480 - Specification for Flat-Rolled Stainless and Heat Resisting Steel Plate, Sheet and Strip.

8. A 500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
9. A 572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
10. A 992 – Standard Specification for Structural Steel Shapes.

C. American National Standards Institute (ANSI):
1. B 15 - Ball Bearings, Local Bearings and Fatigue Life.
2. B 16.1 - ANSI Standard for Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.

1.03 SYSTEM DESCRIPTION

A. System Description:
1. Thickening Process: The sludge, mixed with an emulsion polymer, will enter the flash mixing tank where the polymer and sludge are mixed. The sludge mixture then flows into the base of the flocculation tank. The mixture flows upward to the top of the flocculation tank where a low-shear, adjustable speed mixer will promote flocculation. The flocculated solids and liquid will flow through a tube from the flocculation tank into the base of the thickening drum. The screw inside the thickening drum rotates, moving solids up the drum while filtrate flows from the thickening drum into the effluent drain. Thickened solids are discharge from the end of the thickening drum into the TWAS hopper. The TWAS hopper is connected to a progressing cavity pump, which pumps the thickened solids to sludge holding tank number 2. Mounted above the rotary drum screen will be a self-cleaning wash water spray header. This spray header will keep the rotary drum screen openings clear of solids.
2. Sludge Characteristics: Sludge characteristics to be fed to the volute thickener are as follows:
   a. Type of Feed Sludge: Waste Activated Sludge (WAS) from an activated sludge treatment train.
   b. Feed Solids, Percent Total Suspended Solids: 0.5 to 1.5.
   c. Feed Volatile Solids Content, Percent: 60 to 80.
   d. Feed pH Range: 5.5 to 8.0.
   e. Feed Maximum Solids Size, Inches: 1.

B. Minimum Performance Requirements:
1. As a minimum, rotary drum thickener shall be capable of operating at the following conditions for the specified feed sludge characteristics:
   a. Maximum Hydraulic Feed Rate: 400 gpm.
   b. Minimum Hydraulic Feed Rate: 200 gpm.
   c. Solids Feed Rate at Maximum Hydraulic Feed Rate: 3,000 lbs/hr at 1.5-percent total suspended solids (dry weight basis) or 1000 lbs/hr at 0.5-percent total suspended solids (dry weight basis).
   d. Solids Feed Rate at Minimum Hydraulic Feed Rate: 1500 lbs/hr at 1.5-percent total suspended solids (dry weight basis) or 500 lbs/hr at 0.5-percent total suspended solids (dry weight basis).

C. Vendor Control Panel
1. Refer to Section 13390 for requirements regarding the packaged vendor control panel.

1.04 SUBMITTALS

A. The Owner will provide product data and shop drawings including I/O map and operation and maintenance manuals.

B. Quality Control Submittals:
   1. Field functional and operational test reports.
   2. Certified test results for sludge conditioning system.
   3. Certificate of Installation.
   4. Manufacturer's installation manuals.

C. Warranties.

D. Certificates.

E. Technician Qualifications Resume: Submit resume of technician to perform volute thickener adjustments, inspections, performance testing, and training.

F. Training Course Outline.

1.05 NOT USED

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare products for shipment by:
   1. Applying grease and lubricating oil to bearings and similar items.
   2. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.

B. Transport products by methods that avoid product damage.

C. Provide equipment and personnel to handle products by methods to prevent soiling or damage.

D. Upon delivery, promptly inspect shipments. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products. Immediately store and protect products and materials until installed in Work.

E. Store products with seals and legible labels intact.

F. Store moisture sensitive products in weathertight enclosures.

G. Maintain products within temperature and humidity ranges required or recommended by manufacturer.

H. Connect and operate space heaters during storage when ambient temperatures fall below temperatures recommended by manufacturer.

I. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces.

J. Exterior storage of fabricated products:
   1. Place on aboveground supports which allow for drainage.
   2. Cover products subject to deterioration with impervious sheet covering.

3. Provide ventilation to prevent condensation under covering.

K. Provide access for inspection.

L. Maintain equipment per the manufacturer's recommendation and industry standards, including oil changes, rotation, etc.

M. The volute thickener system, including all principal system elements, is to remain assembled and mounted on its structural steel skid for simplified movement and installation. Any equipment removed for transport from Walnut Creek WWTP to the project site is to be re-installed to its pre-transport condition.

1.07 SEQUENCING AND SCHEDULING

A. Equipment anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place when concrete is placed.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. General start-up and testing of equipment:
1. Conduct functional testing of mechanical or electrical systems when each system is substantially complete and after general start-up and testing procedures have been successfully completed.

D. Field functional and operating testing requirements as specified in this section.

1.08 WARRANTY

A. As the volute thickener is an existing piece of equipment furnished by the Owner, a warranty is not required on this piece of equipment.~~Warranty: Warrant equipment free of defects in material and workmanship for 1 year from the date of Operational Acceptance of the equipment by the Owner; cover parts and labor.~~ AD3

1.09 MAINTENANCE

A. If special tools are required for the service and maintenance of the unit, provide one complete set of tools.

B. Spare parts:
1. Provide the following spare parts for the progressing cavity pump:
   a. Pump thrust bearing set.
   b. Pump radial bearing set.
   c. Stators: 1 every type.
   d. Shaft coupling or U-joint: 1 every size and type.
2. Provide the following spare parts for the volute thickener unit:
   a. 1 spray water solenoid valve.
3. Provide the following spare parts for the polymer blending unit:
   a. Provide 1 complete set of special tools needed to assemble and disassemble the polymer blending unit.
   b. 1 mixing water solenoid valve.

C. Contractor, inspector, and Owner's maintenance representative shall inventory and account for all tools and spare parts delivered to the site. Each party will sign a turnover agreement. Owner will then take possession and responsibility for items.

PART 2 PRODUCTS

2.01 IDENTIFICATION

A. If not already present on equipment, identify each unit of equipment with a corrosion-resistant nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, manufacturer's name and location, and any data required by manufacturer for ordering replacements.

2.02 MATERIALS

A. System Components:
   1. Anchor Bolts and Miscellaneous Hardware, Including Bolts, Nuts, Washers, and Fastener Clips: ASTM A 320, Type 316 stainless steel.
   2. Piping and Valve Connections: Flanged or grooved-end pipe for metallic pipe, and solvent-welded socket type for polyvinyl chloride.

2.03 FINISHES

A. Repaint painted surfaces damaged during transport in conformance with manufacturer's standards.

B. Metal surface finishes:
   1. Steel finishes:
      a. Coat metal surfaces, other than stainless steel, with coating system consisting of 2-part epoxy primer, 2 coats of high solids epoxy, and 1 coat of polyurethane topcoat with minimum total dry film thickness of 12 mils.
      b. Coating shall comply with requirements for high solids epoxy and polyurethane coatings in Section 09960.
   2. Stainless steel:
      a. Pickle and passivate in accordance with ASTM A 380 or A 967 to remove free iron, heat tint oxides and weld scale and other impurities to obtain a passive finished surface.

PART 3 EXECUTION

3.01 INSTALLATION

A. The volute thickener, associated equipment, and appurtenances shall be installed under the direction of the system supplier in strict conformance with the manufacturer's installation instructions and with favorable review of shop drawings.

B. Any items on the volute thickener skid considered wear items are to be replaced. Wear items to be replaced include the following at minimum:
   1. Progressing cavity pump (TWAS):
      a. Stator.

b. Pump thrust bearing set.
c. Pump radial bearing set.
d. Shaft coupling or U-joint.

2. Volute thickening unit:
   a. Spray water solenoid valve.
3. Polymer blending unit:
   a. Mixing water solenoid valve.

C. Connect electrical power, hydraulic or pneumatic tubing, water piping, polymer piping, and sludge piping.

3.02 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners.

3.03 FIELD QUALITY CONTROL

A. Process Optimization:
   1. A sludge evaluation shall be performed by the manufacturer. Three weeks prior to optimization process, the Owner will send to the manufacturer a healthy, representative feed sludge sample. The manufacturer shall perform optimization tests for the polymer and inform the Contractor of the polymer selected for optimization.
      a. The Contractor shall notify the Owner 2 weeks prior to the required sludge sample shipping date.
   2. Manufacturer to optimize process including, but not limited to, polymer dosage, location of polymer injection, unit drive speed, and floc drive speed.
   3. Contractor shall supply one 300-gallon (nominal) polymer tote of the selected polymer required for optimization.

B. Functional Tests:
   1. Functional testing of the entire volute thickening system is to be conducted following inspection, installation, and cleaning of the volute thickener.
   2. Testing to be conducted by the Contractor and the manufacturer's representatives in the presence of the Engineer to demonstrate that equipment is capable of performing its specified function in a satisfactory manner without mechanical or electrical defects, binding, or operational difficulties.
   3. Refer to 17100 – Process Instrumentation and Control Systems (PICS) for instrumentation performance acceptance testing requirements.
   4. Performance Test:
      a. Conduct performance tests for volute thickener to verify that the unit meets the minimum performance requirements specified herein.
      b. Performance test for volute thickener shall be 3 consecutive days in duration, 4 hours of operation each day at a WAS feed rate of 240 gpm.
      c. Provide written test procedures including sampling frequency and analysis at least 30 days prior to start of testing. Manufacturer shall recommend optimal polymer and required polymer concentration.
      d. Contractor shall provide recommended polymer; Owner will provide non-potable water, power, and sludge feed. Equipment and systems installed under this project may be used by the manufacturer during the performance test.

e. The manufacturer shall operate the equipment throughout the duration of the test, obtain the samples in the presence of the Owner, and document the data needed to confirm the performance of the thickener unit. Contractor shall immediately transfer samples to the Owner and the Owner will conduct the laboratory tests.
f. One sample of the following flow streams shall be obtained for each hour of operation during the performance test:
    1) Feed sludge.
    2) Filtrate.
    3) Thickened sludge.
    4) Polymer solution.
g. The following process data shall be recorded and documented each half hour of the test:
    1) Feed sludge flow rate, solids concentration, and mass rate.
    2) Polymer dosage and feed rate.
    3) Cumulative thickened sludge flow.
    4) Alarm conditions.
    5) Equipment problems.
    6) Drum drive speed.
    7) Floc drive speed.
h. Performance Test Results:
    1) Laboratory test results prepared by Owner will be transmitted to manufacturer for evaluation to determine acceptability of performance.
    2) Average values for thickened sludge concentration, polymer consumption, and percent capture over the 16-hour test period shall be determined for the volute thickener.
    3) The performance of the volute thickener will be deemed acceptable if the average values for each operating parameter meet or exceed the specified minimum value with an upper confidence limit of 95 percent.
    4) In the case of unacceptable performance, the manufacturer shall have 30 days to make equipment modifications, implement physical or operational changes, make adjustments to the equipment, and conduct supplemental tests.
i. In the case of unacceptable performance, the manufacturer shall then have 30 days in which to perform, at its sole expense, any supplemental testing, equipment adjustments, changes, or additions and request an additional retest of the unacceptable system. If the modified equipment then does not meet the minimum performance requirements of this Specification, a payment retention shall be imposed as damages.
j. Until the volute thickener supplied successfully completes performance testing, 15-percent of the System Price will be retained by the Owner.

5. Excessive vibration or noise shall be corrected.
6. Verify that all connections, including connections for sludge conditioning system, are watertight.
7. During testing, Contractor shall make all final adjustments necessary to place equipment in satisfactory working order.
8. Test and calibrate all controls, switches, automatic valves, and other instrumentation and control equipment associated with the rotary drum thickening system specified herein, in accordance with the manufacturer's printed instruction over the full operating range of the equipment.

9. Provide certified test report.
10. Coordinate testing with functional testing of other related equipment.

3.04 MANUFACTURER'S FIELD SERVICES

A. Coordinate field service work with the Manufacturer's Representative, Owner, and Engineer prior to initiating such work.

B. Contractor shall furnish a qualified Manufacturer's Representative to provide manufacturer's field services.

C. Require Manufacturer's Representative to perform the following services as described below. The specified durations are the minimum required time on the jobsite. Additional services and/or longer durations shall be provided as needed at no cost to Owner to meet the required quality of work.
   1. Installation Assistance: As required.
   2. Installation Inspection: 1 Workday.
   3. Start-up/Testing Assistance: 1 Workday.
   4. Process Optimization: As required.
   5. Training as further described below: 8 hours.
      a. Operations Training: 4 hours.
      b. Mechanical Maintenance Training: 2 hours.
      c. Electrical Maintenance Training: 2 hours.
   6. Post Start-up Field Visit: 1 Workday.

D. Additional Training Requirements:
   1. The manufacturer shall submit a course outline plan two weeks before training starts, with proposed class material and class schedule to the Owner for approval. Training will begin only if the class material and class schedule have been reviewed and approved by the Owner.
   1. Training will begin only after the rotary drum thickener has successfully passed all required functional and performance tests.
   2. Subjects of instruction shall include the following:
      1) Start-up procedures.
      2) Shutdown procedures.
      3) Troubleshooting.
      4) Selection of proper polymer types and dosages.
      5) Operating adjustments for performance optimization.
      6) Preventative maintenance.
      7) Removal and replacement of rotary drum thickener components.
      8) Maintenance procedures.
      9) Emergency procedures.
      10) Record keeping.
      11) Mechanical unit function and description.
      12) Variable frequency drives.
      1) System controls.

END OF SECTION

[AD3] Addendum No. 3

SECTION 11366B

CLOTH MEDIA FILTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pre-engineered cloth media filter systems.

B. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Tag numbers:
   1. Disk Filter No. 1 FLTR-DISKFILTER-01.
   2. Disk Filter No. 2 FLTR-DISKFILTER-02.
   3. Disk Filter No. 3 FLTR-DISKFILTER-03.

1.02 REFERENCES

A. American Gear Manufacturers Association (AGMA).

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. 841 - IEEE Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).

C. National Electrical Manufacturer's Association (NEMA).

1.03 SYSTEM DESCRIPTION

A. Replacement equipment and appurtenances for Disk Filter Nos. 1 and 2, including, but not limited to items stated in this Section, shall be supplied by Aqua-Aerobics Systems, Inc.

B. Additive Alternate: A complete cloth media filter system for Disk Filter No. 3, including, but not limited to items stated in this Section, shall be supplied by one manufacturer.

C. Cloth media filter system including provisions for sludge wasting or tank draining, backwashing, and all appurtenances necessary for a complete and operational modular assembly:
   1. All mechanisms and components that are required to complete a functional cloth media filter system should be furnished by manufacturer consisting of center tube assemblies with cloth media disks, drive assemblies, backwash/sludge discharge assemblies, automatic valves, instruments, electrical controls, and local control panels for each filter.

D. Contractor, as supplied by the manufacturer, shall install each cloth media filter system.

E. Additive Alternate: 1 complete disk cloth media filter system for Type I system shall be provided.

F. 2 replacement disk cloth media filter systems for Type I system shall be provided.

G. Process description:
   1. Type I System:
      a. Secondary effluent flows by gravity from the filter splitter structure through the filter influent pipe into the disk filter unit. The filter basin contains a series of circular disks covered with a pile cloth media. Water passes through the media and is collected in a centertube. Under normal operation, the disks are stationary and partially submerged.
      b. The filtrate flows by gravity through the centertube and over the effluent weir, into the effluent chamber prior to discharge. If for any reason the pipe or channel downstream of the filter is obstructed, the liquid level will rise within the filter basin and the high basin level alarm will be initiated.
      c. Solids are separated from the water by the filter panels mounted on the 2 sides of the disk segments. The solids are retained on the filter disks while the filtrate flows to the inside of the disks into the centertube.
      d. As the effluent flows through the filters, solids are accumulated on the filter media. As the mat is formed, headloss through the media increases, causing the liquid level in the filter basin to rise. A backwash cycle may be initiated by one of the following:
         1) At a predetermined liquid level setpoint (A) within the filter basin, the backwash cycle is initiated. Only 2 filters are allowed to perform a backwash operation simultaneously (this includes the two existing AquaDisk® filters, Disk Filter Nos. 1 and 2). Therefore, the timing of backwash operation is staggered from filter group-to-filter group (after a backwash cycle is completed, a new backwash cycle begins on another set of filters, etc.).
         2) At a specified duration of a filter run. This mode of operation is based on an automated timer. Only 2 filters are allowed to perform a backwash operation simultaneously (this includes the two existing AquaDisk® filters, Disk Filter Nos. 1 and 2). Therefore, the timing of backwash operation is staggered from filter to filter (after a backwash cycle is completed, a new backwash cycle begins on another set of filters, etc.).
         3) At a user command. This mode of operation is based on a user-requested backwash operation. The filters have a minimum level setpoint for a backwash to take place. Therefore, a backwash operation can only begin if the level in the filter basin is at the specified minimum.
         4) At a high basin level alarm within the filter basin, the backwash cycle is initiated. Only 2 filters are allowed to perform a backwash operation simultaneously (this includes the two existing AquaDisk® filters, Disk Filter Nos. 1 and 2). Therefore, the timing of backwash operation is staggered from filter group-to-filter group (after a backwash cycle is completed, a new backwash cycle begins on another set of filters, etc.).
      e. During backwash, the media disks remain partially submerged while the disks are rotated by a single-chain drive mechanism:

1) Solids are backwashed from the pile cloth media surface by liquid suction through backwash shoes (5) positioned on both sides of each disk. These spring loaded backwash shoes contact the pile cloth media to provide the necessary suction for optimum cleaning efficiency.
2) During backwash, disks are cleaned in multiples of two. The disks rotate slowly while a backwash/waste pump draws filtered water from the centertube through the pile cloth media on an inside-to-outside, or reversed, flow path. This provides effective cleaning of the pile cloth media over the entire disk.
3) By the end of the backwash cycle, the basin water level returns to its normal operating level. Backwash water is typically directed to the headworks.
4) Filtration continues while the filter is in backwash mode.

f. During normal filter operation, some particulates will settle to the bottom of the filter tank. On a periodic basis, they must be removed. A perforated manifold at the bottom of the basin is connected to the backwash/waste pump. An automatic solids waste valve on the suction side of the backwash/waste pump prevents free flow when the solids waste mode is inactive. When the solids waste mode activates, the automatic solids waste valve opens, connecting the perforated manifold to the backwash/waste pump. After a short delay to allow the automatic solids waste valve to open fully, the backwash/waste pump runs for an operator selected duration. When the selected duration completes, the backwash/waste pump shuts off and the automatic solids waste valve closes.

g. Backwash frequency correlates to the solids loading rate. The number of backwashes provides an indication of how quickly solids accumulate within the filter basin. Scheduling the solids waste mode based on backwash frequency automatically ties the solids waste cycle frequency to the solids loading rate. The time-based solids waste cycle interval ensures that periodic solids removal occurs regardless of solids loading rate. When the specified number of backwash cycles have completed, the solids waste cycle will begin immediately following the backwash. This reduces stop/start cycles on the backwash/waste pump.

H. Design criteria:

1. Treatment capacity:
   a. Number of units: 2 for Type I system (plus an additional Type I system as an Additive Alternate).
   b. Total design flow: 2.25 million gallons per day (with all units in service).
   c. Total peak flow: 9 million gallons per day (with all units in service).
   d. Rated peak flow for each unit: 6 million gallons per day.
2. Influent characteristics:
   a. Maximum total suspended solids: ~~220~~20 milligrams per liter. AD3
   b. Average total suspended solids: ~~190~~ 15 milligrams per liter. AD3
   c. Minimum wastewater temperature: 17 degrees Fahrenheit.
   d. Average wastewater temperature: 23 degrees Fahrenheit.

3. Effluent characteristics:
    a. The effluent characteristics from the cloth media filter units shall meet the following average day limit under stated treatment capacity and influent characteristic conditions:
        1) Total suspended solids: 5 milligrams per liter or less (24-Hour composite average).

I. Design requirements:
1. Type I System, Disk Filter Nos. 1 and 2: Manufacturer shall provide the following components at a minimum:
    a. 2 centertube assemblies.
        1) Cloth media socks for each centertube assembly.
        2) Neoprene media sealing gaskets.
    b. 2 local control packages and accessories.
        1) Including, but not limited to, backwash pump VFDs.
2. Additive Alternate: Type I System, Disk Filter No. 3: Manufacturer shall provide the following components at a minimum:
    a. 1 center drum assemblies.
    b. 1 chain drive system assemblies.
    c. 6 filter media assemblies, each consisting of 2 filter disks.
    d. 1 backwash pump, support, and accessories packages.
    e. 1 backwash valve assembly.
    f. 1 backwash shoe assembly.
    g. 1 sludge valve assembly.
    h. 1 external piping assembly.
    i. 1 basin level transducer assembly.
    j. 1 pressure transmitter assembly.
    k. 1 vacuum gauge transmitter assembly.
    l. 1 local control packages and accessories.
3. Additional equipment and appurtenances required by the manufacturer.
4. Fit in space as indicated on the Drawings.
5. Align with piping as indicated on the Drawings.
6. All components shall be suitable for outdoor installation, including, but not limited to; controls, wiring and electrical devices, valve operators, materials, piping, and valves.
7. Each equipment shall be delivered to the job site as an assembled unit, when practical, ready for operation after connection to utilities provided by the Contractor.

J. Prefabrication:
1. Manufacturer and Contractor shall coordinate all instrumentation and other device supports to be fabricated with the cloth media filter system and include these supports on the submittal drawings to the Engineer.
2. Submittal shall include preliminary program sequences for PLC as described in Sections 17100 – Process, Instrumentation and Control Systems (PICS) and 17101 - Specific Control Strategies.
3. Final program sequences shall be submitted for acceptance prior to installation.

K. Provide supports for piping, instrumentation, and other equipment mounted within, against or adjacent to the cloth disk filter units.

L. Piping supports external to the filter units shall be provided by the Contractor.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. List of parts recommended by the Manufacturer to be replaced after 1 and 3 year(s) service.
   2. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Submit wiring, control schematics, and control logic diagrams for all electrical and control components furnished.
   2. Include a completed data sheet (ISA data sheet) for each instrument supplied.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Vendor operation and maintenance manuals: As specified in Section 01730 - Operations and Maintenance Manuals.

F. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in Section 15050 – Common Work Results for Mechanical Equipment.

B. Special warranty:
   1. Disk Filter No. 1-2 equipment
      a. Duration: 1 year after substantial completion on new components only. AD3
   2. Additive Alternate: Disk Filter No. 3
      a. 1 year after substantial completion.
   3. Respond to written notification of a warranty problem within 48 hours.
      a. The response will consist of an immediate remedy in which the manufacturer will correct the problem, or if the problem cannot be immediately corrected due to insufficient materials, the manufacturer will notify the Owner of the anticipated schedule for equipment repair.

PART 2 PRODUCTS

2.01 GENERAL

A. The Type I system equipment covered by these Specifications shall call attention to certain features but may not cover all details of the construction of the media filter system. Ancillary and accessory devices, within the confines of the manufacturer's scope, necessary for the treatment system performance shall be included by the manufacturer whether specified or not.

2.02 MANUFACTURER (TYPE I SYSTEM)

A. Manufacturer: One of the following or equal:
   1. Type I System:
      a. Aqua-Aerobic Systems, Inc.

B. The drawings are based on the Aqua Disk Filters, Model ADFSC-54X12E-PC system by Aqua Aerobics System. Contractor shall be responsible for the cost of any changes that may be required to accommodate alternate model and equipment by other manufacturers, including, but not limited to, structural, mechanical, and electrical work. Contractor shall also pay any additional engineering costs necessary for revisions of drawings and Specifications required to accommodate alternate equipment.

2.03 BASIN

A. The steel cloth media filter basins shall be installed in a concrete basin on concrete equipment pads, as indicated on the Drawings and as specified in this Section.

2.04 TYPE I SYSTEM

A. Drive assembly:
   1. The drive assembly shall consist of gearbox, drive sprocket, drive chain, and a chain guard. Belt drive systems or systems with multiple drive units per filter shall not be acceptable.
   2. Gearbox: Parallel in-line helical-type, AGMA Class 1 with a 3/4 HP drive motor rated for 460 volt, 3 phase, and 60 Hertz. Provide IEEE 841 compliant motor.
   3. Drive sprocket: Nylon.
   4. Chain: Nylon with Type 18-8 stainless steel link pins.
   5. Chain guard: Type 316L stainless steel.

B. Center tube assembly:
   1. Each center tube assembly shall include a Type 304L minimum 1/4-inch thick stainless steel center tube weldment, driven sprocket, wheel assemblies, and frame and cloth assemblies.
   2. Effluent port seal: Include a chlorine resistant Viton™ V-ring effluent port seal.
   3. Drive sprocket: Multi-segment U.H.M.W. polyethylene.
   4. Fasteners: Type 316 stainless steel.

C. Mounting brackets and hardware:
   1. Each filter basin shall be fitted with Type 316 stainless steel mounting brackets to accommodate attachment of the filter components to the basin.
   2. All mounting brackets shall be attached to the basin wall with Type 316 stainless steel wedge anchors and hardware.
   3. Through-the-wall spool piping and all filter external piping shall be provided by the Contractor.

D. Filter cloth assemblies:
   1. General:
      a. Each of the 3 steel filter basins (including 1 additive alternate) shall include 12 disk assemblies.
      b. Each cloth disk assembly shall be comprised of 6 individual segments; each consisting of a cloth media sock supported by an injection molded polypropylene co-polymer frame.
      c. During filtration, the filter assemblies shall operate in a static condition with no moving parts. The filter system shall provide for the collection of filtered solids on the outside of the cloth media surface to allow for the direct contact of cleaning systems. Filtered effluent shall be used for backwash. The filter flow path shall be from the outside of the disk to the inside. Systems with flow paths from the inside to the outside of the disk that collect filtered solids and plastic debris on the interior surfaces of the disk will not be acceptable.
   2. Cloth/frame assemblies:
      a. Shall be constructed such that each segment is easily removable from the center tube, without special tools, to allow for removal and replacement of the cloth at the point of installation. Systems requiring special tools and/or the return of media segments to the factory for replacement shall not be considered.
      b. Each cloth disk assembly shall have a minimum of 53.8 square feet of effective submerged filtration area. Effluent filtration area is defined as only the portion of the disk that is submerged during filtration. Any disk area that is not submerged shall not be considered as effective area.
      c. Each disk shall be divided into no more than 6 segments and shall be easily removable for service.
   3. Cloth media:
      a. Cloths shall be of chlorine-resistant polyester (PES) fiber pile construction with polyester backing material having a nominal filtration rating of 10 microns. Granular media and screens having structured identical openings shall not be allowed.
      b. The cloth media shall have an active filter depth of 3 to 5 millimeters to provide additional collisions between solids particles and the media within the media depth, resulting in capture of solids across a broader particle range. The cloth depth shall also provide storage of captured solids, reducing backwash volumes while maintaining an operational headloss. Woven mesh or microstrainer type disk with no filtration depth are not acceptable.

E. Influent weir box:
   1. Each filter shall include a Type 316 stainless steel influent weir box. The weir box shall be mounted to the filter basin interior using Type 316 stainless steel wedge anchors and hardware. The basin wall must be smooth and plumb to facilitate a quality installation.

F. Backwash/sludge discharge assembly:
   1. General:
      a. The backwash function shall incorporate a pump that draws filter effluent from the centertube through the cloth, thereby removing accumulated solids from the cloth surface.
      b. Each backwash/sludge discharge assembly shall include a backwash system assembly, an external piping assembly, and 1 backwash pump with variable frequency drive.
   2. Backwash system assembly:
      a. Number: 1 assembly per filter.
      b. Each assembly includes:
         1) Type 304 stainless steel backwash collection manifolds.
         2) Type 304 stainless steel threaded unions.
         3) PVC sludge collection manifolds.
         4) Nylon combination nipples.
         5) 1-1/2-inch wire reinforced flexible hose.
         6) 2-inch wire reinforced flexible hose.
         7) Stainless steel hose clamps.
   3. External piping assembly:
      a. Number: 1 assembly per filter.
      b. The external piping assembly shall include:
         1) Brass combination nipples.
         2) PVC combination nipples.
         3) 2-inch wire reinforced flexible hose.
         4) 0 to 30 inches mercury vacuum gauges.
         5) 0 to 15 pounds per square inch pressure gauges.
         6) Ball valves (2 per filter).
   4. Backwash pumps:
      a. Manufacturers: The following or equal:
         1) Gorman Rupp, model T4A60-B
      b. Type: Externally mounted centrifugal pump.
      c. Number: 1 for Disk Filter No. 3 only.
      d. Tag numbers:
         1) Additive alternate: Disk Filter No. 3: FLTR-BACKWASHPUMP-03.
      e. Pump shall be provided with a 7.5 horsepower, 460 volt, 3 phase, 60 Hertz TEFC motor and operate at 1,750 revolutions per minute.
      f. Pump shall be rated for 270 gallons per minute at 36 feet total dynamic head.

G. Backwash valves and sludge valve:
   1. Type 316 stainless steel ball valve manufacturer standard.
   2. Each valve shall have a 115 volt, 1 phase, 60-cycle OPEN/CLOSE service electric actuator. Valve actuator shall include a compartment heater and thermostat, with limit switch feedback to the microprocessor in both the OPEN and CLOSE positions. The actuator shall be EIM or approved equal.

H. Anchor bolts:
   1. Contractor shall provide anchor bolt calculations as specified in Section 01612 - Seismic Design Criteria.
   2. Contractor shall provide and install anchor bolts for the filters and backwash pumps. Anchor bolts shall be Type 316 stainless steel and as specified in Section 721S – Steel Structures and SP721S.

I. Piping:
   1. Provide all piping, supports, bracing and fitting as required and as acceptable to the Engineer.

J. Finishes:
   1. Contractor shall provide field finishes as specified in Section 09960 - High-Performance Coatings.

K. Controls and control panel:
   1. Control panel:
      a. Refer to Section 13390 – Packaged Control Systems for all materials and components associated with the packaged control panels.

L. Instrumentation:
   1. Manufacturer shall furnish the following components as a part of the filtration system:
      a. Pressure transducer (1 per filter): Manufacturer standard supply.
      b. Pressure and vacuum gauges (2 each per filter): Manufacturer standard supply.
      c. High-level float (1 per filter): Manufacturer standard supply.
      d. Vacuum sensor (1 per filter): Manufacturer standard supply.
   2. Provide all I/O, setpoints, and alarms to the Plant SCADA PLC. SCADA shall be able to command the units on and off and adjust all setpoints.
   3. Provide at least 4 spare analog inputs (4-20 mA) to be used for turbidity.

2.05 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: Provide the following:
   1. 6 filter frame and cloth segments.
   2. 1 Viton™ V-ring effluent port/center tube seal.
   3. 1 Backwash/Solids valve actuator for Type I system.

B. Special tools: Provide special tools if required for normal operation and maintenance.

2.06 INSTRUMENTATION AND CONTROLS

A. Disk Filters:
   1. References:
      a. 50N01.
      b. 50N02.
   2. Equipment:
      a. FLTR-FILTER-01 – Disk Filter No. 1.
      b. FLTR-FILTER-02 – Disk Filter No. 2.
      c. Additive Alternate: FLTR-FILTER-03 – Disk Filter No. 3.
      d. FLTR-BACKWASHPUMP-01 – Backwash Pump No. 1.

e. FLTR-BACKWASHPUMP-02 – Backwash Pump No. 2.
f. Additive Alternate: FLTR-BACKWASHPUMP-03 – Backwash Pump No. 3.
g. FLTR-F1-PV-01 – Filter No. 1 Backwash Valve 1.
h. FLTR-F1-PV-02 – Filter No. 1 Backwash Valve 2.
i. FLTR-F1-PV-03 – Filter No. 1 Backwash Valve 3.
j. FLTR-F1-PV-04 – Filter No. 1 Backwash Valve 4.
k. FLTR-F1-PV-05 – Filter No. 1 Backwash Valve 3.
l. FLTR-F1-PV-06 – Filter No. 1 Backwash Valve 6.
m. FLTR-F1-PV-07 – Filter No. 1 Solids Waste Valve.
n. FLTR-F2-PV-01 – Filter No. 2 Backwash Valve 1.
o. FLTR-F2-PV-02 – Filter No. 2 Backwash Valve 2.
p. FLTR-F2-PV-03 – Filter No. 2 Backwash Valve 3.
q. FLTR-F2-PV-04 – Filter No. 2 Backwash Valve 4.
r. FLTR-F2-PV-05 – Filter No. 2 Backwash Valve 3.
s. FLTR-F2-PV-06 – Filter No. 2 Backwash Valve 6.
t. FLTR-F2-PV-07 – Filter No. Solids Waste Valve.
u. Additive Alternate: FLTR-F3-PV-01 – Filter No. 3 Backwash Valve 1.
v. Additive Alternate: FLTR-F3-PV-02 – Filter No. 3 Backwash Valve 2.
w. Additive Alternate: FLTR-F3-PV-03 – Filter No. 3 Backwash Valve 3.
x. Additive Alternate: FLTR-F3-PV-04 – Filter No. 3 Backwash Valve 4.
y. Additive Alternate: FLTR-F3-PV-05 – Filter No. 3 Backwash Valve 3.
z. Additive Alternate: FLTR-F3-PV-06 – Filter No. 3 Backwash Valve 6.
aa. Additive Alternate: FLTR-F3-PV-07 – Filter No. 3 Solids Waste Valve.
bb. FLTR-F1-LIT-01 – Filter No. 1 Level Transmitter.
cc. FLTR-F2-LIT-01 – Filter No. 2 Level Transmitter.
dd. Additive Alternate: FLTR-F3-LIT-01 – Filter No. 3 Level Transmitter.
ee. FLTR-F1-LSH-01 – Filter No. 1 Level Switch High.
ff. FLTR-F2-LSH-01 – Filter No. 2 Level Switch High.
gg. Additive Alternate: FLTR-F3-LSH-01 – Filter No. 3 Level Switch High.
hh. FLTR-BWPU1-PIT-01 – Backwash Pump No. 1 Vacuum Switch.
ii. FLTR-BWPU2-PIT-01 – Backwash Pump No. 2 Vacuum Switch.
jj. Additive Alternate: FLTR-BWPU3-PIT-01 – Backwash Pump No. 3 Vacuum Switch.
kk. FLTR-BWPU1-FIT-01 – Backwash Pump No. 1 Flowmeter.
ll. FLTR-BWPU2-FIT-01 – Backwash Pump No. 2 Flowmeter.
mm. Additive Alternate: FLTR-BWPU3-FIT-01 – Backwash Pump No. 3 Flowmeter.
nn. FLTR-SUMPPUMP-01 – Sump Pump No. 1.
oo. FLTR-SUMPPUMP-02 – Sump Pump No. 2.
pp. FLTR-SP-LSL-01 – Sump Float Level Switch Low.
qq. FLTR-SP-LSH-01 – Sump Float Level Switch High.

3. Abstract:
   a. Secondary effluent flows by gravity from the filter splitter structure through the filter influent pipe into the disk filter unit. The filter basin contains a series of circular disks covered with a pile cloth media. Water passes through the media and is collected in a centertube. The filtrate flows by gravity through the centertube and over the effluent weir, into the effluent chamber prior to discharge.

b. Solids are separated from the water by the filter panels mounted on the 2 sides of the disks. The solids are retained on the filter disks while the filtrate flows to the inside of the disks into the centertube. A backwash pump is used to remove solids that accumulate on the cloth media disks (Backwash Mode) and the floor of the filter basin (Solids Waste Mode).
c. Two submersible pumps will be located in a sump inside the Filter Complex and will be automatically controlled to pump rainwater and washdown water out of the Filter Complex.

4. Hardwired interlocks:
   a. Backwash Pumps will not be allowed to run if:
      1) Minimum Level for Backwash setpoint is not achieved.
      2) Hand-Off-Auto Selector is not in Auto.
      3) No Backwash Valve Limit Switches are OPEN.
   b. Backwash Pump will shut down if:
      1) Backwash/Waste Pump High Vacuum switch is activated.
      2) Backwash/Waste Pump High Discharge Pressure switch is activated.
      3) Basin Level drops below the Minimum Level for Backwash or Minimum Level for Solids Waste.
   c. Solids Wasting, including Backwash Pumps, will not be allowed to start if:
      1) Minimum Level for Solids Waste setpoint is not achieved.
      2) Hand-Off-Auto Selector is not in Auto.
   d. As indicated on the Drawings, manufacturer's Control Strategies, and Section 17100
5. Local Control
   a. Local Manual Control
      1) Disk Filter Drive:
         a) The HAND-OFF-AUTO switch for the Filter Drive Motor can be switched to HAND at the local manual level.
         b) Setting the drive to HAND control will operate the drive independent from PLC interlocks.
         c) With the drive set in HAND, the drive can be manually started and stopped at the local control panel.
      2) Filter Backwash Pumps:
         a) The HAND-OFF-AUTO switch at each filter can be switched to Hand at the local manual level.
         b) Setting the pumps to HAND controls will operate the pumps independent from PLC interlocks.
         c) With the pumps set in HAND, the pumps can be manually started and stopped at the local control panels.
      3) Filter Backwash and Solids Waste Valves:
         a) The Open-Close-Auto controls at each valve can be switched to Open or Close at the local manual level.
         b) Opening or Closing the valves manually will operate the valves independent from PLC interlocks.
      4) Sump Pumps:
         a) The pump has a LCP with an HOA selector switch, a START button and a STOP button. When the pump is in HAND, an operator may locally start and stop the pumps.

b. Local Remote Control
    1) Disk Filter Drive:
        a) None.
    2) Filter Backwash Pumps:
        a) None.
    3) Filter Backwash and Solids Waste Valves:
        a) None.
    4) Sump Pumps:
        a) Duty sump pump will automatically start when the Sump Float Level Switch High is activated.
        b) Pump will automatically turn off when the Sump Float Level Switch indicates the level in the sump reaches the shut-off level setpoint.
c. Monitoring
    1) Disk Filter Drive:
        a) RUN status.
    2) Filter Backwash Pumps:
        a) RUN status.
    3) Filter Backwash and Solids Waste Valves:
        a) None.
    4) Sump Fluid Level:
        a) None.
d. Alarms/Alarm Responses
    1) Disk Filter:
        a) Basin Level HIGH.
    2) Filter Backwash Pumps:
        a) Backwash/Waste Pump Vacuum HIGH.
    3) Filter Backwash and Solids Waste Valves:
        a) None.
    4) Filter Sump Level:
        a) High level alert.

6. PLC Control
    a. Remote Manual Control
        1) Disk Filters
            a) When the HAND-OFF-AUTO switch is in AUTO, the Filter Drive is available for Remote Control. Additionally, the Manual/Automatic software switch at the HMI must be in Manual mode.
        2) Filter Backwash Pumps:
            a) When the HAND-OFF-AUTO switch is in AUTO, the Backwash pumps are available for Remote Control. Additionally, the Manual/Automatic software switch at the HMI must be in Manual mode.
        3) Filter Backwash and Solids Waste Valves:
            a) The OPEN-CLOSE-AUTO switch at each valve must be set to AUTO to allow SCADA control. Each valve may be manually opened and closed through the SCADA system, using software OPEN-CLOSE pushbuttons.
        4) Sump Pumps:
            a) The operator may assign the duty pump manually at the HMI.

b. Automatic Control
    1) Disk Filters
        a) When the centertube drive HAND-OFF-AUTO switch is in AUTO, the Filter Drive is available for Remote Control.
        b) The Filter Drive will be switched on at the beginning of a Backwash or Solids Waste Cycle after the Backwash Valve is open and will be turned off after the Backwash Pump is turned off.
    2) Filter Backwash Pumps:
        a) The following events can trigger a backwash cycle:
            (1) The filter basin level is above the Backwash Start setpoint.
            (2) The length of time between backwashes has exceeded the setpoint.
            (3) A request occurs via user command.
            (4) High level float switch in the filter basin is triggered.
        b) The following events can trigger a Solids Waste Cycle:
            (1) The number of backwashes since the last solids waste cycle has exceeded the setpoint.
            (2) The length of time between solids waste cycles has exceeded the setpoint.
            (3) A request occurs via user command.
        c) To control the backwash/waste flow, a Proportional-Integral-Derivative (PID) loop is used to automatically adjust the speed of the backwash/waste pump. The initial starting pump speed is the Feed Forward Output, and is determined from the last operating state of the loop. After running at this speed for the initial Feed Forward Delay, the flow PID loop switches to automatic and takes active control over the pump speed.
        d) Once in automatic, the speed of the pump is regulated by a PID loop in the control system PLC. The PID loop adjusts the pump speed to keep the flow within range of the setpoint. If the flow falls below the setpoint, the pump speed will be increased. If the flow rises above the setpoint, the pump speed will decrease.
        e) The PID loop used to control the pump speed may need to be “tuned” to provide accurate control. There are three tuning parameters for any PID loop: Gain (proportional), Reset (integral), and Rate (derivative). For this application, the Rate term is locked at zero to disable it.
        f) When the solids waste mode activates, the automatic solids waste valve opens, connecting the perforated manifold to the backwash/waste pump. After a short delay to allow the automatic solids waste valve to open fully, the backwash/waste pump runs for an operator selected duration. When the selected duration completes, the backwash/waste pump shuts off and the automatic solids waste valve closes.
    3) Filter Backwash and Solids Waste Valves:
        a) At the start of the Backwash Cycle, there is a delay to allow the first automatic backwash valve to open fully before starting the backwash/waste pump. Once the automatic backwash valve is open, the drive motor turns and the backwash/waste pump runs for the operator specified duration. When the specified duration has elapsed, the first automatic backwash valve closes and the

next one opens (if applicable). This sequence continues until each automatic backwash valve has been open for the specified duration.

b) When the solids waste mode activates, the automatic solids waste valve opens, connecting the perforated manifold to the backwash/waste pump. After a short delay to allow the automatic solids waste valve to open fully, the backwash/waste pump runs for an operator selected duration. When the selected duration completes, the backwash/waste pump shuts off and the automatic solids waste valve closes.

4) Sump Pumps:
   a) When the liquid level in the sump activates the High-High level switch, a pump is automatically turned on.
   b) Sump pump automatically turns off when the Low Level Switch in the sump indicates the level in the sump reaches the shut-off level setpoint.
   c) The pumps shall operate in a duty/standby sequence. The duty sump will alternate after each pump is stopped.
   d) The duty pump will be automatically alternated by the SCADA PLC based on instantaneous runtime and rest time.

c. Monitoring
   1) Disk Filter:
      a) Drive RUN status.
      b) Basin Level.
   2) Filter Backwash Pumps:
      a) Backwash Time Interval.
      b) RUN status.
      c) Backwash Flowrate.
      d) Pump speed (if flowmeter fails).
      e) Continuous Backwash Duration.
      f) Continuous Backwash Flowrate.
      g) Continuous pump speed (if flowmeter fails).
      h) Extended Backwash Interval.
      i) Extended Backwash Duration.
      j) Extended Backwash Start Time – Hour and Minute.
      k) Solids Waste Time Interval.
      l) Solids Waste Duration.
      m) Solids Waste Flow.
      n) Solids Waste Pump Speed (if flowmeter fails).
      o) # of Backwashes between Solids Waste.
      p) Waste Flow PID Loop.
   3) Filter Backwash and Solids Waste Valves:
      a) Backwash Valve Position.
      b) Backwash Duration (per valve).
   4) Sump Fluid Level:
      a) None.

d. Alarms/Alarm Responses
    1) Disk Filter (Typical of 3 filters, including 1 additive alternate):
        a) PLC Battery LOW.
        b) PLC Output Power FAIL.
        c) PLC Detected POWER LOSS.
        d) PLC Input Power FAIL.
        e) UPS On Battery.
        f) UPS Low Battery.
        g) UPS Bypass Power.
        h) Ambient Temperature OUT-OF-RANGE.
        i) Basin Level HIGH.
        j) Basin Level too LOW for Backwash.
        k) Basin Level too LOW for Solids Waste.
        l) Basin Level Tank Level Transmitter vs. High Level Switch Mismatch.
        m) Basin Level OUT-OF-RANGE.
        n) Drive Motor #1 FAILED TO RUN.
    2) Filter Backwash Pumps:
        a) Backwash/Waste Pump Vacuum HIGH.
        b) Backwash/Waste Pump Vacuum OUT-OF-RANGE.
        c) Backwash/Waste Pump VFD FAILED TO RUN.
        d) Backwash/Waste Pump VFD Speed Command OPEN WIRE.
        e) Backwash/Waste Pump VFD Speed Feedback OUT-OF-RANGE.
        f) H-O-A Controls NOT IN AUTO for Backwash.
        g) Waste Flow DEVIATION from Setpoint.
        h) Waste Flow OUT-OF-RANGE.
    3) Filter Backwash and Solids Waste Valves (Typical of 6 Backwash Valves and 1 Solids Waste Valves per Filter):
        a) Backwash Valve #1 FAILED TO OPEN.
        b) Backwash Valve #1 FAILED TO CLOSE.
        c) Solids Waste Valve FAILED TO OPEN.
        d) Solids Waste Valve FAILED TO CLOSE.
    4) Sump Fluid Level:
        a) High level alert.
7. Failure modes:
    a. None.

2.07 QUALITY ASSURANCE (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

A. Make up piping with a sufficient number of unions to permit ready breaking of lines for maintenance.

B. Support and brace plastic pipe to prevent sagging or overstressing of pipe and connections, and, furthermore, support piping so that no item of piping system transfers load or strain to equipment.

C. Adequately support piping so that operation of valves will not cause pipe to show appreciable movement.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning, 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 4-day minimum.
      b. Functional Testing: 1 trips, 3-day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing:
   1. Electrical and Controls:
      a. Conduct testing as specified in Section 17380 – Field Instrumentation and Sensing Devices.

D. Functional testing:
   1. Equipment:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test:
         1) Ensure that each individual system component has been correctly installed, shall operate fully in the manner intended, and is ready to perform its function as part of an integrated system when placed in continuous operation:
            a) Verify connecting piping is leakproof and properly anchored.
         2) Demonstrate that the equipment, including the backwash pumps, is capable of performing its specified function in a satisfactory manner without mechanical or electrical defects, binding, or operational difficulties.
         3) Repair visible leaks.
         4) Test and calibrate controls, switches, automatic valves, and other instrumentation and control equipment associated with the cloth media filter units as specified in this Section, in accordance with the Manufacturer's printed instruction over the full operating range of the equipment.
      c. Conduct Level 2 Vibration Test.
      d. Conduct Level 2 Noise Test.
   2. Electrical and Controls:
      a. Test witnessing: Witnessed.
      b. Conduct testing as specified in Section 17380 – Field Instrumentation and Sensing Devices.

3. System:
    a. Test witnessing: Witnessed.
    b. Conduct Level 2 General Equipment Performance Test.
    c. Conduct Level 2 Vibration Test.
    d. Conduct Level 2 Noise Test.
    e. Process test:
        1) Guaranteed performance testing:
            a) Demonstrate filters performance per Performance Design Criteria:
                (1) The sampling information and results shall include the influent characteristics (TSS and NTU) and effluent characteristics (TSS and NTU) to demonstrate that the equipment meets the required performance. Plant staff will conduct sampling and laboratory analysis. Manufacturer is not required to be present for process test. [AD3]
            b) Scheduling:
                (1) Perform first performance test when the initial 2 filters are online and operational.
                (2) Perform second performance test within the first month after the disc filters are completely installed and operational.
                (3) Duration: Run performance tests for a minimum of 5 continuous days each and must meet the performance requirements on a 24-hour average daily basis.

END OF SECTION

[AD3] Addendum No. 3

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SECTION 11375

SINGLE STAGE CENTRIFUGAL AIR BLOWERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. The Blower Manufacturer shall furnish, test, and place in satisfactory operation a complete and automated aeration blower system for aeration basins, and miscellaneous small demands, as specified herein. The Blower Manufacturer shall be responsible for the performance of the proposed system at all operating conditions, including the review and acceptance of the proposed system inlet piping, valving, louvers, filters, and outlet silencers, piping, valving, diffusers and hydraulic operating conditions. In addition, the blower manufacturer shall be responsible for the complete dissolved oxygen DO) control system, including DO probes, flow meters and flow control valves as shown the Drawings. The aeration blower system shall be made up of, but not be limited to the following primary components:
   a. Blower units.
   b. Electric motors.
   c. Oil lubrication system.
   d. Inlet transition and silencer.
   e. Air filtration system.
   f. Valves.
   g. Instrumentation for D.O. Control system
      1) DO sensors
      2) Thermal flow meters
      3) Flow control valves
      4) Header pressure transmitter
   h. Miscellaneous appurtenances.
   i. Blower instrumentation and controls including dedicated local control panel (LCP) system for each blower unit as well as a separate aeration system master control panel to be provided by the Blower Manufacturer. Refer to Section 13390 – Packaged Control Systems.
   j. All other appurtenances and custom designed LCP software necessary for a complete and automated blower system.
2. Blower units, blower instrumentation, blower controls, and appurtenances shall be provided as shown on the Drawings and as specified herein for a complete and automated blower controls in conjunction with the aeration control system.
3. All equipment, instrumentation, and accessories specified in this Section and referenced to other Specification sections shall be furnished by the Blower Manufacturer, who shall be responsible for the suitability and compatibility of all included equipment. The Blower Manufacturer shall provide all services, equipment, and appurtenances required to achieve a complete, fully integrated, and operational system across the entire specified range of air flows and pressures, meeting all design conditions, testing requirements, performance guarantees, and warranties specified herein.

4. The Blower Manufacturer shall submit certified equipment arrangement drawings and foundation requirement drawings for approval as part of the Initial Shop Drawing submittal. The Drawings shall show all pertinent layout dimensions and weights for the blower units with specific requests (if applicable) for minor changes to the Drawings to accommodate performance and installation of equipment proposed to be furnished. Configuration changes should include any applicable changes required including but not limited to, inlet design from inlet louvers, transition from filter room openings through inlet silencer to the blower inlet, discharge silencer, valves, piping, blowoff valve sizing and the piping layout for each individual blower and piping connection to the main header.
5. Any additional components or accessories not included in the Blower Manufacturer's scope of supply and required for a complete system shall be provided by the Contractor. Blower Manufacturer shall provide the Contractor a complete list of all equipment, lubricants, hardware, gaskets, and any other accessories not included in their scope of supply, which are required to provide a workable, operational, and complete system. Contractor shall include cost of these items in the Bid Price.
6. All equipment specified shall be installed by the Contractor.

1.02 REFERENCES

A. American National Standard Institute (ANSI)/American Society of Mechanical Engineers (ASME):
   1. PTC-10 – Power Test Code for Centrifugal Compressors and Exhausters.
   2. B16.1 – Gray Iron Pipe Flanges and Flange Fittings: Classes 25, 125, and 250.

B. American Petroleum Institute (API):
   1. 547 - General Purpose Form-Wound Squirrel Cage Induction Motors - 250 Horsepower and Larger.
   2. 617 - Axial and Centrifugal Compressors and Expander-compressors.

C. American Society for Testing and Materials (ASTM):
   1. ASTM A 48 – Specification for Gray Iron Casting.
   2. ASTM A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   3. ASTM A 276 – Standard Specification for Stainless Steel Bars and Shapes.
   4. ASTM A 278 – Specification for Gray Iron Castings.
   5. ASTM A 536 – Standard Specification for Ductile Iron Castings.
   6. ASTM A 564 – Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

D. American Gear Manufacturers Association (AGMA):
   1. AGMA 6001-D97 – Design and Selection of Components for Enclosed Grade Drives.
   2. AGMA 6005-C90 – Standard Specification for Measurement of Sound on Enclosed Helical, Herringbone, and Spiral Bevel Gear Drives.
   3. AGMA 2000/A88 – Gear Classification and Inspection.

E. National Electric Manufacturers Association (NEMA):
   1. NEMA MG 1 – Motors and Generators.

F. Institute of Electrical and Electronic Engineering (IEEE):
   1. IEEE 4, Standard Technique for High-Voltage Testing.
   2. IEEE 43, Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   3. IEEE 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   4. IEEE 118, Standard Test Code for Resistance Measurement.

G. International Organization for Standardization (ISO):
   1. ISO 9001 – Quality Management Systems – Requirements.

H. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
   1. ASHRAE Test Standard 52-76.

I. National Electrical Manufacturer Association (NEMA):
   1. NEMA 250 – Enclosures for Electrical Equipment.

J. Underwriters Laboratories, Inc (UL):
   1. UL-508 - Industrial Control Equipment.

1.03 SYSTEM DESCRIPTION

A. The blower units will be used for providing variable airflow to the Aeration Basins, and associated channel air. The Blower's Local Control Panels (LCPs), including LCP software license and software configuration, blower's instrumentation, and accessories shall optimize blower operation. All items specified in this Section shall be supplied by the Blower Manufacturer to provide a single source of responsibility for a properly functioning blower system with the objective to minimize power consumption while providing the optimum discharge pressure. All components shall be new. Components specified establish minimum requirements only, and do not relieve the Blower Manufacturer of responsibility for providing a properly functioning system.

B. Some equipment may require modifications from the standard equipment to meet specification. Electrical, instrumentation, and other systems shall comply with other sections of these Specifications except as specifically modified within this section.

C. Blower Manufacturer shall furnish all blower equipment, including field engineering services for commissioning, startup services and Owner's personnel training services, plus assistance to the Contractor for installation of all blower equipment and coordination with SCADA System Subcontractor, which is required to provide a workable, operational, and complete blower system. The Specifications define the blower's system general requirements; however, Blower Manufacturer shall provide all necessary ancillary equipment and services. Changes, if required, shall be per the Blower Manufacturer's recommendations, subject to the Engineer's acceptance.

D. The existing Aeration System master control panel (MCP) that controls the existing blowers and monitors aeration system instruments will remain during construction of the new blower's system and temporary construction transition using some existing blowers, plus operating concurrently with two new blowers and their respective new master control panel, as necessary to maintain and assure uninterruptible air supply to the plant aeration system.

E. The Blower Manufacturer / Supplier shall provide additional field technical services, including coordination and work with Contractor's SCADA System Subcontractor, plus provide technical services for temporary construction transition using some existing blowers, plus operating concurrently with two new blowers and respective controls, as necessary to maintain and assure uninterruptible air supply to the plant aeration system and integration of the new aeration system with a new Master Control Panel and the new Blower's LCPs.

F. The Blower Manufacturer shall provide field engineering services for installation and startup of each new blower in multiple construction phases, as necessary to replace each existing blower with new blower equipment and maintain the plant aeration system in continuous reliable operation.

1.04 BLOWER PROTECTION SETTINGS

A. The Blower Manufacturer will coordinate with the design provisions and characteristics of existing motor control center and existing reduced voltage motor starters, to ensure that all protective overcurrent devices, protective settings and control interlocks are appropriate. All protective devices and motor protective settings shall be submitted and reviewed by the Engineer. The Contractor and Blower Manufacturer shall submit to the Engineer, the blower's motor curves to verify compatibility and performance with protective devices.

1.05 QUALITY ASSURANCE

A. The Blower Manufacturer's machining and assembly shops must be ISO 9001 certified.

B. Equipment which is a "standard product" with the Blower Manufacturer shall be modified, redesigned from the standard mode, if necessary, or furnished with special features, accessories, materials, or finishes as may be necessary to conform to the detailed requirements of these Specifications and Drawings.

1.06 NOISE LEVEL

A. The maximum free field sound pressure level at any point at a distance of 5 feet or more from any blower/motor surface shall not exceed 88±3 dBA with the blower running at any position of inlet guide vanes and variable discharge diffuser vanes.
   1. The specified maximum free field sound pressure level of 88±3 dBA includes the noise emitted from any possible source from the blower system components in the Blower Room, including but not limited to: the noise from motor, speed increaser gear, coupling, blower, inlet and discharge piping, fittings, valves, silencers, and any reflected noise.

B. The sound pressure level shall be measured on each individual blower during the preliminary equipment tests of field-testing after installation in the Blower Room and with one blower running.

1.07 SUBMITTALS AND OPERATION AND MAINTENANCE MANUALS

A. Submittals shall be made in accordance with Section 01300 – Submittals. All submittal dimensions, calculations and other information to be in USA English units of measure. In addition, provide this information in the following format:
   1. The Blower Manufacturer shall submit certified equipment arrangement drawings and foundation requirement drawings for approval as part of the Initial Shop Drawing submittal. The Drawings shall show all pertinent layout dimensions and weights for the blower units with specific requests (if applicable) for minor changes to the Drawings to accommodate equipment proposed to be furnished. Configuration changes should include any applicable changes required including but not limited to, inlet design from transition from filter room openings through inlet silencer to the blower inlet, discharge silencer, valves, piping, blowoff valve sizing and the piping layout for each individual blower and piping connection to the main header.
   2. Submittal notes and exceptions shall be organized by specification paragraph. Provide detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt non-specified materials to the arrangement or details shown.
   3. General description of blower with all performance data, blower curves, and model.
      a. Provide a statement of the lateral critical speeds of each blower system.
      b. Provide a speed torque curve for the motor and blower with inlet guide vanes and variable diffusers in starting position, computed for specified minimum inlet temperature and minimum humidity. Certify that the motor starting torque is suitable for the blower requirements.
   4. Mechanical drawings with general arrangement showing blowers and base dimensions, motor, motor terminal boxes, floor mounting, blower lube oil system, skid piping for blowers and lube oil system, overall weights with and without oil, weights of largest components requiring removal for maintenance, and clearances required around unit for maintenance access.
      a. Include a drawing indicating the critical building coordination dimensions. Dimensions shall include (but not be limited to) all blower system components between the inlet silencer and the connection point of the discharge piping at the Main Header.
   5. Guaranteed shaft power of each blower unit.
   6. Weight and inertia of rotating parts.
   7. Speed-torque curve of the blower for operation at minimum inlet guide vane position as well as maximum inlet guide vane position.
   8. Blower Local Control Panel:
      a. Description of process control logic and process and instrumentation diagrams. Control Logic Descriptions shall be in the Blower Manufacturer’s standard format. A sample will be provided in the Index and must be available electronically by request.
      b. Drawings of all local control panels to include:
         1) Enclosure.
         2) Components layout within the LCP.
         3) Electrical ladder diagram.
         4) Interconnect to all components outside the LCP panel.
         5) Door layout.
         6) LCP cooling equipment.
         7) Temperature thermostat.

c. Operating description for LCPs and master control panels. As a minimum, provide software license in the name of the Owner, a copy of the software ladder logic covering all logic and sequences of operation.
d. Typical Operator Interface Unit (OIU) screens shall be provided with detailed descriptions, the various tattletale monitors, preventative maintenance items, and data logging features.
e. Provide a detailed description that demonstrates the simultaneous and continuous efficiency optimization of the variable inlet guide vanes and variable diffuser vanes to obtain the lowest power consumption based on the three variables of inlet temperature, differential pressure, and machine capacity.
f. Provide control block diagram depicting interconnection of all blower components and external components the system must connect with. Including but not limited to:
    1) Peripheral devices.
    2) Device Net field networks.
    3) Connection of the new aeration system Master Control Panel to the Owner's SCADA PLC network system.

9. Preliminary input/output (I/O) listing for all control panel programmable logic controllers (PLC).
10. Factory Blower Tests: Submit a detailed test plan with complete piping and instrumentation configuration diagram per ASME PTC 13 showing inlet and discharge air test pipe size. The location, type, and quantity of all major instruments necessary for performance data, including those on air, and lube oil with corresponding distances from reference points, shall be identified per ASME PTC 13 requirements. As a minimum, the detailed test plan shall include:
    a. Quality control procedures.
    b. Air end/gearbox ASME PTC 13 test procedure and method of calculating results.
    c. Functional testing of entire package, including oil lube system, instrumentation, ancillary components, each individual blower Local Control Panel (LCP).
    d. Test equipment calibration certificates. All test equipment shall be calibrated and certified by an independent test agency no more than 12 months prior to the test date. Certificates shall show the stability of calibration over a period of at least one year per ISO 9001, Paragraph 4.11.
    e. Upon completion of factory performance test, Blower Manufacturer shall submit ASME PTC 13 test results report to Owner and Engineer for review and approval.
11. Unloading, handling, storage, and maintenance requirements.
12. Spare parts recommendation list.
13. Recommended lubricants.
14. Surface preparation and shop paint specifications.
15. Instrument settings.
16. Troubleshooting guide.
17. List of components and catalog cuts fully describing all items:
    a. Mechanical and structural components.
    b. Instruments.
    c. PLC and related components.
    d. Operator Interface Unit (OIU).

e. Electrical components.
f. Vibration monitoring.

18. Maintenance summary forms (for Operations and Maintenance Manual, only).
19. Blower Factory Test Report: Factory test reports as described herein with test reference standard identified.

B. Motor and related submittals:
1. Submit descriptive bulletins for motor and pertinent accessories.
2. Complete bill of material identifying all accessories.
3. Weight of complete motor and of rotating parts.
4. Electrical data:
a. Voltage and phase.
b. Nameplate horsepower.
c. Nameplate service factor.
d. At rated horsepower and voltage:
1) Full load amps.
2) Revolutions per minute.
e. Efficiency at 1/2 and 3/4 and full load.
f. Power factor at 1/2 and 3/4 and full load.
g. Locked rotor withstand time, with the motor at ambient temperature and at its maximum rated operating temperature, at 70 percent, 80 percent, 90 percent, and 100 percent of rated voltage.
h. NEMA design.
i. Description of insulation system.
j. Winding insulation class and rated ambient temperature.
k. Motor data for short-circuit and coordination study, including:
1) Submit design values for machine characteristics, including the following:
a) Subtransient reactance ($X"_d$).
b) Transient reactance (X'_d).
c) Negative sequence reactance (X2).
d) Zero sequence reactance (Xo).
5. Motor Performance curves:
a. Torque, current, and power factor vs. speed curves at 100 percent rated voltage.
b. Torque and current curves at 80 percent rated voltage.
c. Rotor and stator thermal damage curves.
d. Motor damage, safe stall time and acceleration curves at 80 percent, 90 percent and 100 percent of rated voltage.
6. Motor Accessories data:
a. Space heaters:
1) Voltage.
2) Watts.
b. Winding and bearing temperature detectors:
1) Quantity and location.
2) Type.
3) Rating.
4) Recommended alarm and trip settings in degrees Celsius for the stator winding and bearing temperature detectors.
7. Motor Mechanical data:
a. Bearing design and bearing life calculations.
8. Motor data verifying compliance with motor specifications.

9. Motor protective relay and interconnection with motor's winding RTDs.
10. Recommended spare parts list.
11. Itemized list of special tools required.

C. Operation and Maintenance Manuals per Section 01730 - Operations and Maintenance Data:
   1. Furnish manuals with instructions covering all details pertaining to operation and maintenance of all equipment and identifying all parts.
   2. Submit in accordance with Section 01730 - Operations and Maintenance Data including the following:
      a. As-built drawings.
      b. Product data.
      c. Installation instructions.
      d. Lubrication requirements.
      e. Complete parts list indicating which parts must be ordered with the blower serial number.

1.08 TOOLS AND SPARE PARTS

A. The Blower Manufacturer shall furnish all special tools and appliances necessary to disassemble, service, repair, and adjust the equipment and appurtenances.
   1. Tools (except for the air and oil filters) shall be supplied in a rolling tool chest for long-term storage, and marked "Tools and Parts for Aeration Blowers", along with a complete description on contents.

B. The Blower Manufacturer shall provide the following spare parts:
   1. One complete set of all bearings for the blowers, engines, and motors.
   2. One complete set of O-rings, gaskets, and seals for the blowers, engines, and motors.
   3. One servomotor for inlet guide vanes.
   4. One servomotor for variable diffuser vanes.
   5. One oil pump, complete with electric motor.
   6. One set of oil filter cartridges for each unit.
   7. One set of first stage inlet air filters for each unit.
   8. One set of fine secondary inlet air filters for each unit.
   9. One complete set of fans
   10. Motor spare parts recommended by the motor manufacturer for two (2) years of normal motor operation (but not including spare parts already listed).
   11. The Contractor shall provide such special tools and appliances as may be needed to adjust, operate, maintain or repair the 460V motors.

C. See Blower's Local Control Panel specifications for additional required spare parts.

D. All spare parts shall be suitably packaged and clearly identified with indelible markings on the containers.

E. The Contractor shall provide any consumable supplies and parts required for operation and maintenance of the aeration system until Project Substantial Completion.

1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All equipment shall be skid mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

C. Shipment is not to be made until the Blower Manufacturer coordinates shipment to the jobsite with the Contractor, assuring that the equipment will be properly received and stored.

D. Upon receipt, Design-Builder shall store equipment in strict accordance with the Blower Manufacturer’s instructions and connect and energize motor space heaters.

E. Contractor shall be responsible for periodic inspection and rotation of equipment required for extended storage in excess of 6 months.

1.10 WARRANTY

A. Warranty: Warranties will expire 24 months after start-up (which will be the Manufacturer’s certified date the equipment is available for beneficial use), whichever occurs first.

B. Manufacturer's warranty shall be issued in the Owner's name.

C. License all Software to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

A. The blower units shall be motor driven, single-stage centrifugal blowers, complete with integral gearbox and accessories as described herein. Each blower unit shall be provided with axial inlet, side discharge, with the discharge orientation as required to suit the blower discharge connection points into the main header as indicated on the Drawings.

B. All blowers shall be identical.

2.02 BLOWER MANUFACTURER

A. The listing of any manufacturer by name shall not imply tacit approval of same. The selected manufacturer shall be required to meet the Specifications. Standard units of manufacture shall be modified, as necessary, to meet all elements of these Specifications, including all experience requirements and packaging of blowers and controls.

B. The blower layout and design is based on being able to fit the blower manufacturer's model listed in this Section. If alternative equipment is furnished, Blower Manufacturer shall be responsible for redesign of piping, structure, and controls system and all other impacted work to ensure a complete and functional installation.

C. The blowers and associated package equipment shall be manufactured and supplied by one of the manufacturers listed below.
   1. Howden Roots, LLC.
   2. Lone Star Blower.

2.03 BLOWER DESIGN CRITERIA

A. All the conditions specified herein shall be as defined in ASME PTC 13. All the pressures and temperatures specified herein refer to stagnation conditions as defined in ASME PTC 13. Inlet conditions are defined as the conditions that exist at the inlet flange of the blower. The discharge conditions are defined as the conditions that exist at the discharge flange of the blower or outlet flange of the discharge cone. Each of the aeration blowers shall be sized and designed for the following rated conditions in Table 1:

Table 1 Blower Sizing and Design Criteria	
Number of Blowers	2 plus 1 standby
Gas Handled	Atmospheric Air
Site Elevation Above Mean Sea Level	486 feet
Barometric Pressure	14.44 psia
Volumetric Flow Rate per blower (corrected to 14.7 psia 68 degrees Fahrenheit and 36 percent relative humidity (RH)) for Required Mass Flow Rate of Air	2,050 scfm
Stagnation Inlet Conditions:	
a. Pressure	14.44 psia
b. Temperature	105 degrees Fahrenheit
c. Coincident RH, %	75%
Inlet Capacity (as defined in ASME PTC 13)	2,200 ICFM
Inlet Pressure Drop	0.2 psi
Operating Discharge Stagnation Pressure	23.44 psia
Maximum Discharge Stagnation Pressure	24.44 psia
Motor Characteristics:	
a. Motor Horsepower (hp)	150 hp
b. Maximum Motor Speed	3,600 rpm
c. Motor Voltage Rating	480 volts
d. Motor Power Source and Frequency	3 Phase, 60 Hz

Table 1 Blower Sizing and Design Criteria	
e. Additional motor specifications	See subsequent paragraph 2.06 – Electric Motors
The following range of conditions will occur. Blowers shall not surge or exceed the nameplate motor rating at or between any of the combinations of these conditions and for operating points specified in the power guarantee Section of these Specifications.	
Barometric Pressure	14.44 psia
Stagnation Inlet Conditions:	
a. Temperature	15 degrees Fahrenheit to 110 degrees Fahrenheit
b. Relative Humidity	40 percent to 90 percent
Discharge Stagnation Pressure	22.5.0 - 24.44 psia

B. The blowers shall have a rising pressure characteristic from minimum flow to the surge point with a minimum rise-to-surge of 0.5 psig at any point between the minimum and maximum flow. The blowers shall be capable of operating continuously and satisfactorily at any point between the minimum and the maximum flows, pressures, and temperatures without surge, vibration, hunting, or excessive heating of the bearings.

C. Operation of several blowers in parallel shall be possible without special requirements. The condition of several units running in parallel with different airflow settings shall be met and the safety margin between delivery pressure and surge pressure shall be maintained at the same value for each machine operating in parallel.

D. Blowers of a design requiring synchronization of airflow in order that two or more may operate in parallel shall not be acceptable.

2.04 POWER GUARANTEE

A. The Blower Manufacturer shall submit the guaranteed shaft horsepower (hp) of each blower unit for the operating points in Table 2. The shaft hp of each blower unit shall be defined as the shaft input hp directly off the motor drive shaft and include power consumption of one oil pump at the specified operating points. The guaranteed shaft hp of the blower unit (blower/gear box including the primary oil pump) shall be proven by measuring each guarantee point during the ASME PTC 13 factory tests. The guaranteed shaft hp of each blower unit shall not exceed the hp values Blower Manufacturer submitted.

Table 2 Blower Power Guarantee								
Operating Point	Blower Capacity (scfm)	Inlet Conditions			Discharge Pressure (psia)	Guaranteed Shaft (hp)	Evaluated Factor	Factored Power (hp)
		Pressure (psia)	Temp (degrees F)	RH (%)				
1	2,050	14.44	100	75	23.44		0.15	
2	1,700	14.44	75	60	23.44		0.50	
3	1,350	14.44	75	60	23.44		0.20	
4	1,000	14.44	50	50	23.44		0.15	
Total Factored Power Draw (hp)								
Note: Flow Rate, scfm measured at 14.7 psia, 68 degrees F, and 36% RH								

B. The guaranteed shaft hp numbers at the specified operating points shall be "guaranteed" ASME PTC 13 numbers with zero tolerance.
   1. Each point shall be evaluated by itself. No credit shall be allowed between operating points in the case where the actual shaft hp is less than the guaranteed shaft hp on one point and higher on another point.
   2. In the event that the Total Factored Power Draw (as tested) is in excess of the specified Total Factored Power Draw, the Owner may accept the blowers by imposing a power penalty of $10,500 per horsepower, per blower in excess of the “As Tested” Total Factored and Guaranteed Power Draw. The Penalty shall be calculated to the nearest tenth of a horsepower, for each blower, and deducted from payments. A credit will not be allowed for any blower for which the “As Tested” Total Factored and Guaranteed Power Draw is under that specified. Penalty costs shall be deducted by the Owner from the remaining payment.

2.05 BLOWER UNIT (BLOWER)

A. Blower and integral gearbox casing:
   1. Blower casing shall be made of ductile iron ASTM A 536 60 40 18, vertically split, have a maximum continuous duty design temperature of 400 degrees Fahrenheit, and a design pressure of 50 psig. The blower inlet shall be connected directly to the inlet transition and silencer unit by a flexible connection and ~~36 inch long~~ [AD5]spool supplied by the Blower Manufacturer. Air inlet shall be axial through an annular inlet. The discharge flange shall be faced and drilled to ANSI B16.1, Class 125 pound. A threaded port with threaded plug shall be provided at the lowest point of the casing for drainage. The blower casing shall be provided with lifting lugs capable of supporting the blower/gearbox.
   2. The blower discharge shall be rotated to a vertical position.

3. The gear drive housing shall be of close-grained cast iron ASTM A 48 Class 30B, and sufficiently rigid to maintain the shaft positions under maximum loads. One or two inspection ports, with bolt on covers, shall be provided in the upper portion of the gearbox housing. The ports shall allow access to the gearbox internals for the purpose of inspection.
4. Gearbox configuration shall incorporate a single helical gear set in an over/under or side by side configuration. The overhung impeller and fast-shaft shall operate between the first and second critical speeds. The housing shall be horizontally or vertically split to facilitate inspection of the internals.
5. The blower and gear housing assemblies shall be machined to close tolerances for bearing fit, gear alignment, air, and oil tightness.
6. The gearbox shall be of ample size and rated to transmit the maximum torque and hp input requirements to the blower under all operating conditions and continuous duty.
7. All exposed machined surfaces shall be coated with a corrosion resistant compound prior to shipment.

B. Impellers:
1. The impeller shall be of the open radial flow type, with backward leaning blades. The impeller shall be mounted directly to the output shaft of the gearbox. The impeller shall be attached to the shaft by shrinkfit and locknut arrangement. The impeller shall be statically and dynamically balanced. The axial gap between the impeller and compressor casing shall be adjustable by means of shims to assure the prescribed gap. Gap adjustments by means of machining the casing or shafts are not acceptable.
2. The impellers shall be milled from forged aluminum alloy 15-5 or 17-4. The Blower Manufacturers shall meet the following requirements:
    a. All impellers shall be subject to a 115 percent overspeed spin test for 15 minutes followed by magnetic particle dye or liquid penetrant inspection and dimensional check per API 617.
    b. Provide a 5-year, unconditional warranty of impeller against any failure due to defect in quality or workmanship. The Blower Manufacturer shall replace the failed impeller with the new impeller of same type material, repair any equipment damage at no cost to the Owner, and extend the warranty for an additional 5 years.

C. Variable vanes:
1. The inlet guide vane and variable discharge diffuser system shall facilitate turndown of each blower from 100 percent to 45 percent of capacity based on varying inlet conditions, while maximizing efficiency over the entire turndown range. The operation of the guide vanes may be incorporated with the surge control system to maintain the blower within the safe operating range. Vanes and backplate shall be constructed of Type 316 stainless steel.
2. An automatically adjustable inlet guide vane assembly shall be provided to pre rotate incoming air and thus, maximize efficiency. Inlet guide vanes shall be made in an aerodynamic, streamlined design in cross-section and located in a radial fashion around the annular inlet. The necessary number of asymmetrically profiled vanes shall be determined by the Blower Manufacturer and shall be provided and positioned in a velocity increasing air duct to minimize downstream wakes. Inlet guide vane position shall be controlled by the efficiency optimization software matrix from the LCP.

3. The inlet guide vanes shall modulate simultaneously with the diffuser vanes to continuously optimize efficiency based on the three variables of inlet temperature, differential pressure, and machine capacity. The Blower Manufacturer shall demonstrate, in submittals and testing, the simultaneous efficiency optimization based on these three variables. Step control of vanes for efficiency optimization or control using less than these three variables shall not be acceptable.
4. Variable discharge diffuser vanes shall be provided for capacity control and designed to obtain the highest efficiency over the entire regulating range. Vanes shall be aerodynamically shaped for maximizing efficiency. The necessary number of profiled diffuser vanes shall be provided as determined by the Blower Manufacturer and arranged in a radial fashion around the periphery of the impeller.
5. The inlet guide vane and the variable diffuser assemblies shall be mounted integrally with each blower, multi-leaf and pivoted, and located in cast iron housings. All vanes shall be mounted in permanently lubricated sleeve bearings.
6. Each variable vane assembly shall include a skid-mounted electric actuator, limit switches, position indication, and open/closed indication. Independent floor mounting of the actuator or its operating mechanisms shall not be allowed.
7. The position of each set of vanes, from fully open to fully closed, shall be transmitted to the LCP via an analog signal. Diffuser vane position and maximum/minimum status indications will be provided on the LCP operator interface.

D. Shafts, gears, and seals:
1. Blower and gear shafts shall be machined from heat-treated, forged steel and suitably ground. Any responsive lateral critical speed of the rotating assembly shall be at least 15 percent from the normal operating speed. Any torsional resonances of the package shall be at least 10 percent from the normal operating speed. All rotating elements shall be dynamically balanced and conform to "Design and Selection of Components for Enclosed Gear Drives" (AGMA 6001 D97).
2. Mechanical and electrical run-out of shaft vibration probe sensing areas shall not exceed 0.5 mil.
3. The speed increasing, helical, parallel shaft type gears shall be made of case hardened alloy steel forgings with precision ground gear teeth. All gears shall be manufactured in accordance with the American Gear Manufacturers Association (AGMA 2101-C95) to a minimum AGMA quality number no less than 12, as specified in AGMA 2000/A88.
4. The shaft seals shall be of a non-contact, multi-point, labyrinth type and operated dry. A vented space between air and oil seals shall be provided. Any leakage shall be minimized by having small clearances between female and male parts. The female part shall be made of aluminum or bronze to avoid damage to the shaft in the event of a seal rub. Slinger rings (diameter changes) on the shaft shall be provided in the sealing area to ensure oil is centrifugally slung off the shaft.

E. Bearings:
   1. Option 1: Oil lubricated, angular contact, hybrid roller bearings with steel race and Silicon Nitride (Si_3N_4) ceramic balls shall be used in the gearbox.
   2. Option 2: Drive shaft radial bearings - cylindrical, journal type. Drive shaft thrust bearings shall be multiple segment designed for thrust in both directions. Pinion shaft radial bearings - steel backed tilting pad bearing.
   3. All bearings shall be of alloy steel construction.

F. Oil lubrication system:
   1. A complete lube oil system shall be provided with each blower, installed integral with the blower base and arranged to permit ease of accessibility for operation, maintenance, inspection, and cleaning.
   2. The oil lubrication system shall include all the related instrumentation items listed in the instrumentation part of this section.
   3. One main motor or gearbox shaft driven primary oil pump and one electric motor driven oil pump (as pre-lube, post-lube, and standby) shall be provided, each capable of full capacity and pressure to supply lubrication for the air blower/gearbox when operating and during start/stop. The electric motor driven oil pump shall operate at start/stop of the blower and, at low oil pressure, be activated by the control system located in the LCP. The motor shall be minimum 3 hp, 3 phase, 460 VAC, 60 Hz, TEFC, NEMA premium efficiency. Other motor characteristics shall be as specified and have adequate power to pump oil at the minimum oil temperature of 50 degrees Fahrenheit.
   4. The oil reservoir shall be integral to the blower base, with the reservoir interior de-scaled and rust-proofed by the application of a permanent coating of the manufacturer's standard. The equipment attached to the top of the reservoir shall be mounted by means of gasketed pads. Reservoirs shall be baffled to minimize air entrainment, to isolate foam, be equipped with a suitable sized vent and breather filter, and have a minimum working capacity of 3-minute retention time based on normal flow. The reservoir shall have a minimum 6-inch diameter blind flanged clean out. The reservoir shall be equipped with a 1-1/2 inch NPT valve drain.
   5. All suction openings from each reservoir to the pumps shall be provided with suitable oil strainers. The strainers shall be replaceable and capable of easy removal and cleaning.
   6. The oil filter shall be of the full flow, replaceable cartridge, simplex type with integral transfer valve and capable of removing particles over 10 microns with a clean oil filter element pressure drop not exceeding 15 psi at design temperature and flow. A visual gauge shall indicate when a filter is dirty and requires changing.
   7. An air-to-oil cooler shall be furnished and mounted on the oil reservoir of each blower.
   8. Cooler shall be capable of maintaining required cooling rate at all ambient temperatures of up to 43 degrees Celsius. Calculations shall be submitted with Shop Drawings.

9. The blower room is ventilated, but not heated. The Blower Manufacturer's standard provisions for oil heating shall be provided to heat the oil when the ambient temperature around the blower falls below 50 degrees Fahrenheit. If an electric type oil heater is used, it shall be designed to heat lightweight oils with no more than 15 watts per square inch. The heater and thermostat shall be mounted on the oil reservoir with the contactor located in the LCP. The blower shall not start unless the oil is above 50 degrees Fahrenheit. Low oil temperature warning indication shall be provided on each LCP.
10. Check valves, shutoff valves and relief valves shall be provided on the oil piping where necessary. No shutoff valves are permitted in the drain lines from the blower, speed increaser, or motor bearings to the oil tank reservoir and the lube oil low pressure switch.
11. The lubrication system shall be designed with the capability to provide adequate lubrication to the bearings to prevent damage if reverse rotation occurs.

G. Coupling:
1. A flexible, forged steel, double disc, dry type spacer coupling shall be furnished to connect the blower and motor. Couplings requiring lubrication shall not be allowed. Coupling and spacer shall be balanced to AGMA, Class 8, or better, and sized with a minimum service factor of 1.5. Coupling construction shall be such that either shaft of the unit may be removed without disturbing adjustment of the other. An OSHA approved steel guard shall be provided and installed over the coupling and painted Safety Yellow.
2. The coupling design shall be coordinate with the blower unit components. A complete torsional critical speed analysis shall be conducted by the Blower Manufacturer to ensure that the blower, motor, and coupling are properly designed. The torsional analysis shall be as specified in Article 1.07 Paragraph B. Include data in the submittal to confirm that there are no torsional critical speeds within the operating range of the unit.

H. Equipment base and mountings:
1. Furnish a base of adequate size to support the blower, gearbox, motor, lubricating system, and accessories. The base shall be constructed of fabricated A36 steel in an integral welded box configuration with a drip lip, lifting eyelets and have sufficient rigidity to permit lifting (using a four point lift) with all equipment mounted. The base shall be leveled and grouted at the jobsite using anchor bolts.
2. The base shall be fully self-supporting and mounted on vibration isolators provided by the Blower Manufacturer and be suitable to absorb the weight and vibration of the blower assembly without undue stress or distortion. The vibration isolators shall be designed for a transmissibility of less than 2 percent.
3. The units shall be factory aligned on the base prior to shipment.
4. Submit structural calculations of the equipment base and mountings, including anchor size, stamped and signed by a registered Texas structural engineer.

2.06 ELECTRIC MOTORS

A. General:
   1. Provide blower drive squirrel cage induction motors, premium efficiency in accordance with required blower's horsepower rating.
   2. Refer to Section 16222 for motor requirements.

2.07 INLET TRANSITION AND FILTER/SILENCER

A. Each blower shall be provided with an inlet filter unit placed on the blower pad directly adjacent to the blower and connected directly to the inlet of the blower via flexible coupling, as shown on the Drawings. An inlet silencer shall be integral to this filter unit.
   1. The inlet components shall be designed to have no adverse effects on blower performance.
   2. The entire inlet filter, piping, and silencer unit shall be designed for maximum airflow pressure drop not to exceed 3.9 inches of water column (W.C.)

B. Inlet silencer:
   1. Walls of the silencer shall consist of sandwiched galvanized steel outer skin and an acoustical sound deadening material of one inch should insulation containing an inert barrier, on the inside of the housing. The inert barrier on the walls shall have a think aluminized facing on its exterior, affixed to the barrier with an industrial adhesive. The silencer housing structural frames shall be painted with an enamel coating of the Blower Manufacturer's standard.
   2. The silencer shall consist of a set of lamella, mounted internally in the silencer between the inlet transition and the removable transition spool at the blower inlet, suitably wrapped with sound deadening material.
   3. Lamella construction shall be such that there is no direct line of sight (direct flow) through the lamella, and the lamella so configured such that the line of airflow shall make at least four turns, for maximum attenuation.
   4. An airtight seal shall be provided between the inlet piping and silencer.

C. Air filtration system:
   1. Each blower shall be provided with an air filtration system. Furnish and install fully assembled air filtration systems. The equipment specified shall be fabricated and supplied by a single filter manufacturer. The filter manufacturer shall have had comparable equipment in successful operation for at least 5 years. Each air filtration system shall be rated for an air flowrate of 2,050 scfm at a nominal face velocity of 575 fpm. Maximum clean pressure loss across both filter stages shall be less than 2.5 inches of W.C. The filtration system shall include:
      a. First-stage and second-stage filter assembly in a single rack.
      b. Pressure differential switch/transmitter and gauges.
   2. The filtration system shall be a two-stage system, consisting of a first stage filter assembly, and a second stage filter assembly (in a common rack), pressure switches, and gauges mounted on the outside of the Filter Box for each blower.
   3. Filter assemblies shall be designed by the Blower Manufacturer, suitable for high efficiency filtration of saturated atmospheric air at temperatures of +40 degrees Fahrenheit to +95 degrees Fahrenheit.

4. Air filtration assemblies shall include the filter elements and all framework, housings, supports, instrument and gauge taps, clip angles, anchor bolts, seals and appurtenances required for a complete installation.
5. Filter assemblies for each stage shall be provided in a common rack. Filter assemblies shall provide for proper support and positioning of filter elements, shall be of adequate design strength, shall incorporate positive sealing against air leakage, shall provide for easy maintenance access to each filter element and cartridge without need for disassembly, shall incorporate necessary pressure taps for monitoring filter condition, and shall fit (including necessary maintenance clearances) within the available space shown on the Drawings.
6. Filter assemblies, including housings, filter and frameworks, braces, supports, anchorage, and the like, shall be designed and constructed to withstand a negative pressure differential of not less than 6 inches water column, with a margin of safety of not less than 2. The manufacturer's submittal data shall include the design pressure differential and margin of safety of their assemblies.
7. A set of pressure taps shall be brought out from the filter assembly rack, to an easily accessible exterior location, for connection to differential pressure instruments (as indicated on the P&IDs). The pressure taps shall be designed and installed to provide for valid sensing of differential pressure across the combined stages of filtration. The pressure tap installation shall not interfere with maintenance of the filter elements.
8. Design of the filter assemblies shall emphasize ease of maintenance. Removable/replaceable elements shall be held in place with "quick-release" type retainers, and furnished with gaskets to prevent air leakage or bypass around each filter and the filter assembly frame.
9. Each filter housing shall be factory fabricated and assembled to ensure rigid, air-tight construction.

D. First-stage filter elements:
1. Filter shall be Aeropleat® IV by Camfil-Farr, or equal.
2. First-stage filters shall filter air from the plenum area and shall be of the medium efficiency, dry cartridge, and disposable type.
3. Individual first stage filter cartridges shall have the nominal dimensions of 24 inches by 24 inches by 2 inches deep.
4. The filter bank shall measure 4 filters wide by 4 filters high.
5. The first-stage filter shall contain extended surface, supported pleat filters, each consisting of water-resistant glass fiber dual phase media arranged in a deep pleated pattern with alternating layers of crimped aluminum separators to maintain uniform spacing between the pleats. Each pleated media pack shall be inserted into stainless steel cell sides with a stainless steel header on the air entering side and a stiffener bar on the air leaving side.
6. The filters shall have an average atmospheric dust spot efficiency of not less than 35 percent on 5 micron particles when tested in accordance with ASHRAE Test Standard 52.2. The initial clean resistance for each blower for the first stage air filters shall not exceed 0.23 inches W.C. at a nominal face velocity of 500 fpm at the rated capacity. The maximum pressure drop for dirty first stage air filters shall be 1 inch W.C. The filters shall be Underwriter’s Laboratories Class 2 (minimum) listed when tested according to UL Standard 900.

7. The filters shall be mounted in a galvanized steel holding frame fitted with neoprene sponge gaskets and spring latches for holding the disposable filter cartridges.

E. Second-stage filter elements:
   1. Second stage filters shall be Aeropac® 65 by Camfil-Farr, or equal.
   2. Second stage filters shall filter air from the first-stage filters and shall be of high efficiency, dry cartridge, and disposable type.
   3. Individual second-stage filter cartridges shall have the nominal face dimensions of 24 inches by 24 inches with a depth of 12 inches. The filter bank shall measure 4 filters wide by 4 filters high.
   4. The second-stage filter shall contain extended surface, supported pleat filters, each consisting of water resistant glass fiber media.
   5. The media shall be arranged in a closely pleated manner, separated by sheets of crimped separators, and shall have sufficient net effective area to limit the media velocity at rated air flow to 20 feet per minute.
   6. The filter cell sides shall be 28-gauge (minimum) galvanized steel.
   7. The media separators shall be crimped aluminum and shall have continuous parallel pleats to ensure maximum filter life. The media pack shall be sealed to the cell sides with fine fiberglass packing.
   8. The filters shall be Underwriters Laboratories Class 2 listed according to UL Standard 900. Each filter shall have an efficiency of 95 percent on 5 micron particles when tested by the DOP test method. The initial clean resistance for each blower for the second stage filters shall not exceed 0.45 inch W.C. at a nominal face velocity of 500 fpm at the rated capacity. The maximum pressure drop for dirty second stage air filters shall be 1.5 inches W.C.
   9. The filters shall mount in a welded bevel seal frame assembly. Each individual frame shall be heavy 2-inch by 2-inch mill finish extruded aluminum with a Section weight of approximately 1 pound per foot. The frame joints shall be mitered or coped for precision fitup, then beveled and heliarc welded with a minimum 3/8-inch bead. For maximum strength, welds shall not be ground. Crevices at intersections shall be leveled and sealed airtight with appropriate sealant. Individual frames shall be bolted together to form one continuous high-integrity filter bank.
   10. Individual filters shall be sealed within the frame by 3/4-inch by 1/4-inch neoprene gaskets and anchored by filter clamps attached to the frame with 1/4 inch cap screws spaced at 24-inch intervals (maximum). Clamps shall have a 1-1/2-inch bearing surface.

F. Air filter gauges:
   1. Each air filtration system shall be supplied with one differential pressure switch/gauge to measure differential pressure across the following:
      a. The combined first-stage and second-stage filter.
   2. The instruments supplied shall provide a direct differential pressure readout at the filter package and shall also be capable of providing a common remote alarm signal to the respective blower LCP when the differential pressure measured exceeds a preset level. Setpoint adjustment for the alarm signal shall be controlled by the OIU on the front of the LCP. The ranges of the differential pressure switch/gauges supplied shall be:
      a. Across combined first-stage and second-stage filter: 0 to 5-inch W.C.

3. The pressure switch/gauge shall be mounted on the filter enclosure and shall be fully piped for operation. The Contractor shall provide field wiring per the Blower Manufacturer's standards.

2.08 VALVES

A. Blow-off (bypass) valve:
   1. Provide each blower with a blow-off lug type industrial class butterfly valve as specified in Section 15112 – Butterfly Valves, with seating materials rated for air service for temperatures up to 300 degrees Fahrenheit. Valve shall allow unloaded start-up and shutdown of blower and be suitable for open/close service. The valve operator shall be a motorized type as specified in Specification Section 13447 - Electric Actuators, 120 VAC, 60 Hz, 3-phase NEMA 4X, sized to open/close in 15 seconds or less and rated for open/close service, equipped with open/close limit switches, and shall be suitable for air service up to 300 degrees Fahrenheit. The blow-off (bypass) valve operator shall be controlled from the associated blower LCP. Bolting and gaskets shall be provided by the Contractor. Blower Manufacturer shall confirm that the size of the blow-off line and valve indicated on the Drawings meets the Blower Manufacturer's criteria for blower startup, shutdown, normal operation and surge control. If the Blower Manufacturer determines that they require a larger size blow-off line and valve, they shall note it in their Proposal. A blow-off silencer shall be provided as described herein. The 480 volts power source for the blower's valve actuators shall be provided by the Design-Builder from additional interconnection to existing motor control centers located in the electrical room, adjacent to the blower's room.
   2. Main Header Blow-off valve: Blower Manufacturer shall provide main header blow-off valve, as shown on Drawings 30M06 and 30M08, to release air during conditions when minimum blower output exceeds total air demand. Design of blow-off valve shall follow requirements specified above for dedicated blower bypass valve.

B. Discharge valve:
   1. Provide each blower with a lug type industrial class discharge butterfly valve per Section 15112 - Butterfly Valves and controls, identical to the blow-off valves, except for size and actuation speed. The valve operator shall be a motorized type as specified in Specification Section 13447 - Electric Actuators, 120 VAC, 60 Hz, 3 phase NEMA 4X , sized to open/close in no faster than 30 seconds, equipped with open/close limit switches, a position transmitter and shall be suitable for air service up to 300 degrees Fahrenheit. Blower discharge valve shall be controlled from the LCP. The 480 volts power source for the blower's valve actuators shall be provided by the Design-Builder from additional interconnection to existing motor control centers located in the electrical room, adjacent to the blower's room.

C. Check valve:
   1. Provide each blower with a flange type discharge check valve of the dual, flat plate type with center hinge, spring closure, steel or cast iron body, Viton seal and stainless steel plates, Inconel springs, and rated for temperatures up to 400 degrees Fahrenheit. The valves shall have flat surfaces with the resilient seat facing on the body. The two plates shall be independently supported on the hinge pin and have separate closure springs. Seating shall be against a

flat recess within the valve body, and valves wherein seating is against the cylindrical inner bore of the body will not be allowed.

2. Check valves shall be especially designed and suitable for use with centrifugal blowers, and shall retain positive sealing capability for air services up to 300 degrees Fahrenheit. The valve shall be compatible with blower characteristics and shall be mounted in a horizontal run of piping, as indicated on the Drawings.
3. Coating: High temperature coating 150 to 350 degrees Fahrenheit. Ameron Amerlock 2/400 or equal. Shop prime and finish coat in strict accordance with coating manufacturer's recommendations.
4. Check valves shall be as manufactured by Crane, Techno Corporation, or equal. CHAMPION check valves shall not be acceptable.

D. Blow-off valve silencers:
   1. A carbon steel blow-off silencer shall be provided for each blower and the main air header blow-off valve. The silencer shall be suitable to allow the blow-off air to be vented via air piping to the outside of the blower building. Silencer shall be coated for corrosive outdoor environment.

2.09 MISCELLANEOUS APPURTENANCES

A. Inlet and Discharge expansion joint:
   1. Provide each blower with a rubber expansion joint or stainless steel bellows joint (per Section 15120) capable of withstanding the vacuum, pressure, and temperature under all operating conditions. The expansion joint shall be included with stainless steel flanges drilled for ASME/ANSI B16.5, Class 150 bolt pattern.

B. Discharge silencer:
   1. Provide each blower with a discharge silencer.
      a. Discharge silencer shall be a cone/silencer (Evasé stack) to increase the blower outlet size to the larger diameter air discharge piping, as shown on the Drawings.
      b. Discharge cone/silencer:
         1) Maximum sidewall angle increase shall be 7 degrees per side (14 degrees total included angle). Minimum 10-gauge carbon steel shall be used with discharge flange and bypass flange size as indicated on the Drawings. Suitable instrument connections shall be provided, as required per instrumentation part of this section. The inside of the discharge cone/silencer shall be lined with deep layers of sound absorbing material, resistant to high temperatures, and covered by fiberglass cloth rated for a minimum temperature of 300 degrees Fahrenheit and a perforated steel plate (minimum 10 gauge thickness), so as to form sandwiched layers of the external cone/silencer surface, acoustical material, and internal perforated steel plate.
      c. All discharge silencers shall meet the following noise attenuation requirements:

Octave Band Freq (Hz)	63	125	250	500	1K	2K	4K	8K
Attenuation (db)	5	7	10	20	27	25	20	12

C. Skid terminals boxes:
   1. All skid mounted equipment, including but not limited to the blower and lubrication skids, requiring electrical connections shall be wired to a skid mount terminal box.
      a. This requirement applies to the blower motor vibration sensors, temperature sensors and other appurtenances but not medium voltage motor power.
   2. Provide separate terminal boxes for each of the following voltages:
      a. 120 VAC.
      b. Less than 120 VAC.

2.10 AERATION SYSTEM INSTRUMENTATION

A. Blower Manufacturer to furnish one main air header pressure indicating transmitters for pressure based control. The blower manufacturer shall also provide one thermal mass flow, one flow control butterfly valve and two dissolved oxygen (DO) sensors for each of the four aeration basins. The flow meter and flow control valve shall be mounted on the ~~12”~~8" AD5 main branches, as shown on the Drawings. The DO sensors shall be provided in Zones 5 and 6, as shown on the Drawings.
   1. Refer to Section17380 for pressure transmitter requirements.
   2. Refer to Section 17305 for thermal mass flow meter requirements.
   3. Refer to Section 15112 for butterfly valve requirements and Section 13447 for requirements on electric actuators.
   4. Refer to Section 17506 for requirements on DO sensors.
   5. Installation of the air header pressure indicating transmitters, temperature indicating transmitters and flow control valves to be done by the Contractor, including manual instrument valves and hardware for instrument testing, calibration and bypass.

B. The new aeration system Master PLC controller shall be located in the blower room as shown on the Drawings.

2.11 BLOWER INSTRUMENTATION

A. Blower instrumentation components shall be provided by the Blower Manufacturer. LCP shall be mounted remotely and located as shown on the Drawings. Instruments shall be of high quality to endure the blower’s environment and high accuracy as per the general product requirements commonly specified in wastewater treatment plant environment. These components shall be mounted on the blower skid, except as indicated, with all electrical connections brought to the LCP by the Blower Manufacturer, unless otherwise noted.
   1. Refer to Divsion 17 for instrumentation specifications.

B. Instrumentation for each blower shall include, as a minimum:
   1. Inlet air temperature gauge.
   2. Inlet air temperature transmitter shall be displayed on OIU.
   3. Inlet air filters differential pressure switches:
      a. Measure differential pressure across the first and second stage inlet filters.
      b. Set switch at 1.0 inches W.C. for first stage filters.
      c. Set switch at 1.5 inches W.C. for second stage filters.
      d. Send signal to LCP.

4. Surge switch.
    a. Blower Manufacturer's standard.
5. Discharge air temperature transmitter shall be displayed on OIU.
6. Discharge air temperature indicator.
7. Discharge air pressure gauge.
8. Differential pressure (inlet/discharge) transmitter.
9. Oil temperature transmitter shall be displayed on OIU.
10. Oil temperature gauge.
11. Oil low pressure switch (start standby oil pump).
12. Oil low-low pressure switch (prevent start or stop running blower).
13. Oil pressure gauge.
14. Oil filter differential pressure switch with indicator.
15. Oil level indicator.
16. Low oil level (reservoir) switch.
17. Flow indicator (sight glass).
18. Variable diffuser position transmitter.
19. Inlet guide vane position transmitter.
20. Zero speed switch on gearbox input shaft (detects rotation when blower is off).
21. Blow off valve limit switches.
22. Discharge valve limit switches (open/closed).
23. Current transmitter for each drive motor.

C. Pressure gauges: Liquid filled case with minimum 2 1/2 inch dial face:
    1. Type on suction side of blower: Vacuum gauge calibrated in inches of water.
    2. Type on discharge side of blower: Pressure gauge calibrated in pounds per square inch gauge.
    3. A suitable tee handled corporation stop or ball valve and snubber shall be installed between each gauge and connection to air piping.

D. Switches:
    1. High enclosure air temperature switch:
        a. As recommended by blower manufacturer.
        b. Activation illuminates an alarm and shuts down the blower.
    2. High discharge air temperature switch:
        a. With thermowell, suitable for mounting in discharge piping.
        b. Adjustable over range of 80 to 300 degrees Fahrenheit or as recommended by blower manufacturer. Initial setting as recommended by blower manufacturer.
        c. With local indication of temperature.
        d. Activation shuts down unit and activates an alarm condition.

E. Other safety devices and controls:
        a. The Aeration Blower Master Control Panel shall provide the following statuses to the plant SCADA system:
            1) Blower No. 1 flowrate.
            2) Blower No. 1 running status.
            3) Blower No. 2 flowrate.
            4) Blower No. 2 running status.
            5) Blower No. 3 flowrate.
            6) Blower No. 3 running status.
            7) Blower header discharge temperature.
            8) Blower header discharge pressure.

9) Totalized flowrate.
10) Valve opened. – Utilized during MOV methodology.
11) Valve closed. – Utilized during MOV methodology.
12) Valve position – Utilized during MOV methodology.
13) Valve in remote. – Utilized during MOV methodology.
14) Valve torque. – Utilized during MOV methodology.

b. The Aeration Blower Master Control Panel shall provide the following alarms to the plant SCADA system:
1) Common alarm.
2) Blower No. 1 fault.
3) Blower No. 2 fault.
4) Blower No. 3 fault.
5) Blower header high temperature.
6) Blower header high pressure.
7) Loss of communications.

2. Failure modes:
a. Upon loss of signal from the Aeration Blower Master Control Panel, the plant SCADA system will generate an alarm and the Aeration Blowers will continue running at the last selected speed setpoint.

F. The RTD monitoring system shall include 100 ohm platinum RTDs embedded in the motor windings (two per phase) and in each loaded bearing of both the motor and blower/gearbox. The LCP system shall monitor and display winding and bearing temperatures at the LCP OIU. When the windings or bearings reach a pre-determined temperature, the indicator will illuminate until it is reset or the unit shuts shown. The motor protective relay within the LCP shall receive the motor's RTD signals, and the values shall be displayed on the LCP OIU. Provide the necessary hardware required for direct communication between RTDs, PLC, and the LCP OIU. RTDs may similarly be used to monitor temperature and they shall display alarms as listed in Paragraph B above.

G. Vibration monitoring systems shall be furnished for each blower and associated equipment using proximity probes and "Key Phaser" sensor. The systems shall include, but not limited to the following:
1. Blower:
a. Input shaft (from motor): Motor Bearing Housing Vibration Transmitter (1 per bearing, 2 total)
b. Output shaft (to blower): Compressor Gearbox Casing Vibration Transmitter
2. Install vibration sensors on the components at the factory and wire the sensors to the control panel. The vibration monitoring system will send real-time vibration data, and alarms to the LCP PLC and all of this information will be available at the LCP OIU. The OIU shall include adjustable alarms for the rising vibration levels. Alarms and shutdown signals need to be coordinated between the vibration system manufacturer and the blower system manufacturer. Display all alarms and shutdowns until they are reset. Provide necessary hardware for direct communication between vibration probes, PLC, and OIU.

2.12 CONTROL STRATEGY

A. General Strategy:
   1. Reference Drawings:
      a. 80N01, 80N02, 80N03, 80N04, 80N05.
      b. Section 17506: Analyzers: Dissolved Oxygen (DO)
      c. Section 17380: Pressure/Vacuum Measurement: Direct
      d. Section 17305: Flow Measurement: Thermal Mass.
      e. Section 16222: Electric Motors, Induction, 600V and Below.
      f. Section 15112: Butterfly Valves
      g. Section 13447: Electric Actuators
   2. Abstract:
      a. The Aeration Blowers are controlled by the blower vendor master control panel (MCP) furnished and programmed by the blower vendor.
      b. Two duty and one standby blowers will discharge into a common 16-inch header. Each blower will have a dedicated temperature and pressure instrument which relays information to the dedicated local blower VCP. The common header will have one pressure transmitter, which relays information to the blower MCP.
      c. The blower MCP will accept control inputs from the plant PLC as indicated on the P&IDs.

B. General requirements:
   1. Provide a dedicated packaged local control system for each Blower unit.
   2. Each packaged local control system shall receive a single point 120 Volt, single phase, 60 Hz electrical control power.
   3. Refer to and comply with the additional requirements as shown on the Drawings.
   4. Field instruments, associated mounting brackets, and hardware as required.
   5. Provide all required devices and means to interface the packaged local control system with the equipment as specified herein and as shown on the Drawings for a complete and functional system.
   6. Provide the manufacturer’s standard features for proper operation and protection of a packaged blower system with the additional features as specified herein and as shown on the Plans.
   7. Packaged local control panels shall be connected to the Owner’s aeration system master control panel and SCADA system. Provide all components within the packaged control system to achieve the connectivity as indicated and specified.
   8. Provide for the additional functionality as specified hereinafter.
   9. The packaged system local control panel will mounted remotely, as shown on drawings. Blower supplier shall provide all wires/cables between blower and LCPs.

C. Specific requirements for Vendor Control Panel (VCP):
      a. Refer to Section 13390 – Package Control Systems for requirements on the VCP. Blower room is not a conditioned space - only ventilation is provided. Panels shall be designed as if installed outdoors.

D. Blower Vendor Control Panel (VCP) operation:
   1. Each blower shall be equipped with a VCP. A PLC shall start and shut down blower in a permissive sequence, receive input, monitor and control operating variables. The PLC shall also contain a program for continuous optimization of blower efficiency with respect to changes in capacity, inlet temperature, and differential pressure across the blower.
   2. Each blower VCP shall contain controls for blower motor operation, surge and overload detection, shutdown control and sequencing, alarm and emergency shutdown systems, inlet guide vanes, variable diffuser vanes, discharge valve, bypass valve, and the oil lubrication system operation. On HMI, use visual graphics, per Blower Manufacturer's current standards, and minimum written instructions for the following functions:
      a. Illustrate the process.
      b. Start blower: Indicator flashes until start sequence completed.
      c. Stop blower: Indicator flashes until stop sequence completed.
      d. Local control- remote/auto selector switch position.
      e. Blow off valve position with indicator if it is open for surge control.
      f. Blow off valve operator select position from 0 to 100 percent open.
      g. Discharge valve position.
      h. Discharge valve operator select position from 0 to 100 percent open.
      i. Variable diffuser vane position: Indicator on maximum open/closed.
      j. Variable diffuser vane: Operator select position. Inlet guide vane position: Indicator on maximum open/closed.
      k. Inlet guide vane operator select position.
      l. Electric oil pump running status.
      m. Oil pressure with low pressure indicator.
      n. Oil temperature with high temperature indicator.
      o. Oil filter differential pressure with high indicator. Oil level with low level indicator.
      p. Inlet air temperature with surge indicator.
      q. Inlet air filters 1st and 2nd differential pressures with high pressure indicators.
      r. Discharge air high temperature indicator.
      s. Discharge air high pressure indicator flashes, warning for rising air pressure and impending surge. Indication on high pressure.
      t. Shaft rotation indicator (when blower is off).
      u. RTD bearing/winding temperature high temperature indicator.
      v. High vibration indicator with trend displayed on demand showing vibration that is generating high alarm, blower discharge pressure and flow rate.
      w. General alarm indicator.
      x. Current alarms displayed on demand.
      y. Alarm sequencing history for all alarms on demand, history duration of 1 day or maximum given the available memory.
      z. Global alarm reset.
      aa. Indicator and horn test.
      bb. Alarm horn silence (alarm acknowledge).
      cc. MCC fault indicator.

3. Additional selector switches, pushbuttons, and indicators shall include:
    a. Service/Normal/Test Software selector switch located on the LCP OIU. This switch allows for permissive start of the blower components only in the Service Mode. When in Test Mode, this switch diverts MCC start signal to a "test" relay that simulates motor start to facilitate testing of the system without starting the drive motor.
    b. Emergency stop mushroom button on panel door.
    c. Separate, non-resettable hour meter on panel door.
4. Monitor and indication of all analog signals shall be displayed on the OIU, including, but not limited to:
    a. Motor amps.
    b. Variable diffuser vane position (45 to 100 percent capacity).
    c. Inlet guide vane position.
    d. Oil temperature.
    e. Vibration signals.
    f. RTD bearing/winding temperatures.
    g. All process air, temperature, and pressure analog signals.
    h. Show concise text boxes that appear on the LCP OIU screen to show current step in the blower startup sequence.
5. PLC control:
    a. The Aeration Blower System may be started and stopped with plant DCS system control.
    b. The operator may operate the blowers in either AUTO or HAND mode as selected at the HMI.
        1) In AUTO mode, the blowers will operate as described in the proceeding, MCP section.
        2) In HAND mode, the blowers will operate as described in the proceeding, MCP section.
6. The blowers shall start under an automatic sequence initiated by the local start signal or the remote start signal when in remote/auto control. Upon signal to start, the PLC shall confirm that the inlet guide vanes and variable diffuser vanes are at minimum, the bypass valve is open, and the discharge valve is closed. All vanes and valves shall be equipped with limit switches on both the open and closed position to indicate position. If components are not properly positioned, they shall move to their respective start positions automatically via the PLC logic. If any of the components do not move to the correct positioned for blower startup, software interlocks in the programming shall be provided to stop blower startup sequence after a pre-set time delay. The oil pre-lubrication system shall energize and run for a minimum of 2 minutes pre-lubrication time. Once all pre-start permissive steps are confirmed, the blower motor shall be started. A feedback signal from the reduced voltage solid-state starter (in existing 5 kV motor control center) shall confirm that the main drive motor starter is being energized. When the blower reaches operating speed, as determined by the motor start sequence, the PLC shall open the inlet guide vanes and discharge valve, close the blow-off (bypass) valve, stop the electric oil pump, and release control of the inlet guide vanes and variable diffuser vanes to local/remote control. Provide sequence fail alarm and trip if any portion of the start, run, or stop sequence is not properly executed. The OIU shall annunciate the function that caused the trip.

7. The surge detection system shall sense unbalanced/surge conditions by use of pressure and temperature sensing devices and upon detection of surge, control system shall immediately respond with a corrective action. Detection of surge conditions shall shutdown the blower.
8. Motor overload protection software shall be provided to control the maximum vane setting on the blower, so that motor current limit does not exceed full load rating.
9. The Blower Manufacturer shall provide blower shutdown sequencing in their scope of supply. There shall be three means of shutting down the blower:
    a. Normal Stop – Initiated by pushing the stop button on the OIU or remote stop from the Owner's DCS. The unit normally stops such that no surging occurs.
    b. Soft Stop shall de-energize the main drive motor 8 seconds after alarm initiation to allow the blow-off valve to partially open. Normal post-lube and other normal stop functions follow. Initiated by:
        1) High oil temperature.
        2) High inlet air temperature from surge air recirculating back through the blower. High inlet air temperature alarm shall not be activated when blow-off valve or hoar frost valves are open.
        3) High motor winding temperature.
        4) Discharge valve has not fully opened within 2 minutes after receiving motor energized feedback signal from the Motor Control Center (MCC).
        5) Blow-off valve has not closed within 5 minutes after receiving motor energized feedback signal from MCC.
        6) High discharge pressure or temperature.
        7) Surge (reversal of flow).
        8) High bearing temperature.
        9) High motor amps (first reduce blower capacity then shutdown if high motor amps condition is not cleared).
    c. Emergency Stop shall de-energize the main drive motor immediately and then normal stop functions shall follow. Initiated by:
        1) Pushing emergency stop button.
        2) Low oil pressure.
        3) High vibration.
        4) No feedback signal from MCC during Start Sequence.
        5) Loss of feedback signal from MCC during Normal Operation.
        6) High-high Bearing temperature.
        7) PLC failure.
        8) Sequence failure during startup.
        9) Stop sequence failure during shutdown.
10. The high inlet air temperature (recirculation) alarm shall be active once the blower is running and start sequence is complete. The zero speed switches and the inlet air temperature (recirculation) alarm shall be active when there is no main motor feedback present at the VCP from the MCC. The purpose of both of these sensors is to detect reverse airflow through the compressor.
11. External signals to/from the VCP shall include the following:
    a. Any monitoring and/or alarm signal in the VCP shall be seen on the MCP as well as on the Plant DCS.
    b. To and from Reduced Voltage Starter – (Hardwired digital signals):
        1) Blower Motor START/STOP signal to starter.

2) The following are the feedback from starter:
   a) Running signal.
   b) Fail alarm.

E. Aeration System Master Control Panel (MCP) General:
   1. The aeration system MCP shall be provided by the blower manufacturer. Refer to Section 13390 – Packaged Control Systems for MCP requirements.
   2. The Blower Manufacturer shall provide the control logic and development of algorithms needed to ensure integration between the blower system LCPs and aeration system MCP, to provide a fully functional and optimized blower and aeration air delivery system over the entire specified range of air flows and pressures.
   3. The MCP shall consist of one PLC cabinet:
      a. One new MCP panel shall include a PLC with necessary communication modules, to communicate with the new blowers LCPs, plus control and monitor the aeration system field instruments
      b. One existing PLC cabinet that controls existing blowers shall be removed upon installation and commissioning of the second single-stage blower.
   4. The Master Control Panel shall include the following:
      a. The MCP shall monitor air header pressure and airflow demand control over the entire operating range of the aeration system with any or all of the blowers in service.
      b. The PLC shall receive the main airflow demand 4-20 mA signals, and send signals to each running blower VCP, to increase/decrease online blower capacity to maintain the airflow at the setpoint. The discharge air flow setpoint shall be adjustable from the MCP or from the DCS.
      c. The MCP PLC shall send signals to the blower's VCP, to bring blowers on and off-line and increase/decrease online blower capacity based on cascade control logic. The result being a gradual increase/decrease of air throughout the entire range of 1 to 3 or quantity of blowers online. In the event of a blower failure, the next blower in the pre-selected start sequence shall come online.

F. PLC control:
   a. The blower manufacturer shall take complete responsibility for the aeration and DO control system, as specified herein.
   b. "Total Measured Airflow" is calculated as the sum of the actual flow rates measured by the flow meters at each aeration basin (Instruments: AB-AB1-FIT-01, AB-AB2-FIT-01, AB-AB3-FIT-01, AB-AB4-FIT-01).
   c. "Total Airflow Setpoint" is calculated as the sum of the airflow set points for each aeration basin.
   d. With MCP HMI set to AUTO mode and Plant PLC control in HAND mode:
      1) Manual pressure control:
         a) Pressure setpoint is entered by the operator. The blower MCP will control the individual blower skids based upon the setpoint provided by the plant SCADA system.
      2) Manual flow control:
         a) Flow setpoint is entered by the operator. The blower MCP will control the individual blower skids based upon the setpoint provided by the plant SCADA system.

e. With MCP HMI set to AUTO mode and Plant PLC control in AUTO mode:
    1) The Plant SCADA system shall provide a Total Airflow Setpoint to the vendor-provided MCP.
        a) Flow Mode (without Secondary DO Trim Control):
            (1) The blower MCP compares actual flow rate (Total Measured Airflow Rate) measured by the flow meter at each aeration basin with the flow setpoints (Total Airflow Setpoint).
            (2) The controller output modifies the position of each control valve such that the Total Measured Airflow rate matches the Total Airflow Setpoint.
        b) Flow Mode (with Secondary DO Trim Control) based on "Dissolved Oxygen (DO) Mode":
            (1) Secondary Trim control shall be selectable at SCADA and "enabled" or "disabled" through an available operator selection.
            (2) A desired value of dissolved oxygen is entered at the operator interface:
                (a) Dissolved oxygen concentration is determined by the DO probe in Zone 6 of each Aeration Basin:
                (b) Aeration Basin No. 1 – AB-AB1-AIT-03
                (c) Aeration Basin No. 2 - AB-AB2-AIT-03
                (d) Aeration Basin No. 3 – AB-AB3-AIT-03
                (e) Aeration Basin No. 4 - AB-AB4-AIT-03
        c) DO Trim Mode:
            (1) In DO Trim Mode, the flow rate set point for each aeration basin shall be automatically adjusted based on DO in a cascaded loop control algorithm.
            (2) Each aeration basin shall have an independent DO concentration set point adjustable from the operator interface. The DO set points shall be as follows:
                (a) 0.2 - 5.0 mg/L (adjustable) with an initial value of 2.0 mg/L.
            (3) The measured DO value in the basin shall be based on twelve (12) equally spaced readings from the corresponding DO probe over a time span of 2 minutes (operator adjustable from 1 to 120 minutes). This time-averaged DO value shall be referred to as "Actual DO."
            (4) The flow set point for each aeration basin shall be adjusted in order to maintain the Flow or DO (if in DO Trim Mode) setpoint for the respective aeration basin as follows:
                (a) The flow set point for each aeration basin shall be adjusted sequentially in the following order: Basin 1, Basin 2, Basin 3, then Basin 4. The time delay between the adjustment of each basin in the sequence shall be 5 minutes (adjustable from 1 to 60 minutes). After the adjustment of the flow controller for Basin 4 has been completed and after a time delay of 15 minutes (adjustable from 1 to 120 minutes), the sequential adjustment process shall repeat, starting again with Basin 1.

(b) No Deviation: If the difference between the “Actual DO” and the DO set point is less than the “Inner Deadband” set point of 0.1 mg/L (adjustable from 0 to 0.6 mg/L), then the aeration basin flow rate set point shall not be adjusted.

(c) Small Increment Deviation: If the difference between the “Actual DO” and the DO set point is within the "Inner Deadband" and "Outer Deadband" of 0.1 mg/L and 0.2 mg/l (both adjustable from 0 to 0.6 mg/L), respectively, then the aeration basin flow rate set point shall be adjusted by 50 scfm (adjustable from 0 to 250 scfm). The flow set point shall be increased if the “Actual DO” is less than the DO set point and decreased if the “Actual DO” is greater than the DO set point.

(d) The flow set point shall not be adjusted to a value lower or higher than the minimum and maximum flow rates, respectively, listed above.

(5) For basins out of service or for DO analyzer maintenance purposes, provide a selector switch to skip trim control adjustments to each basin.

2) The following Most Open Valve methodology shall be used to achieve the lowest practical system operating pressure for both with and without secondary DO trim control indicated above:

a) Most Open Valve shall be selectable and "enabled" or "disabled” through an available operator selection.

b) The PLC shall monitor the position of the following aeration flow control valves:

(1) Aeration Basin No. 1: AB-AB1-BFV-01
(2) Aeration Basin No. 2: AB-AB2-BFV-01
(3) Aeration Basin No. 3: AB-AB3-BFV-03
(4) Aeration Basin No. 4: AB-AB4-BFV-01.

c) The PLC shall communicate the revised system operating pressure to the Blower MCP.

d) At regular intervals (initial setpoint of 3 minutes, adjustable from 1 minute to 60 minutes), the control system will assess the position of all control valves in the aeration system, determine which control valve is the highest percent open, and assign that valve as the most open valve (MOV).

e) If the control system determines that the MOV is at a position that is lower than a predetermined low set point (initial setpoint of 70%, adjustable from 60% to 80%), the system pressure set point will be decreased by a predetermined amount (initial setpoint of 0.1 psig, adjustable from 0.05 to 0.5 psig). This pressure setpoint change will cause the MOV (and all the valves in the system) to open.

f) If the control system determines that the MOV is at a position that is higher than a predetermined high set point (initial setpoint of 90%, adjustable from 80% to 99%), the system pressure set point will be increased by a predetermined amount (initial setpoint of 0.1 psig, adjustable from 0.05 to 0.5 psig). The pressure setpoint change will cause the MOV (and all the valves in the system) to close.

g) If the control system determines that the MOV is at a position between the low and high set points, the pressure setpoint will not change.

(1)

3) If MOV is enabled, the Plant SCADA system shall provide a Pressure Setpoint to the vendor-provided MCP.

f. The OIU shall have multiple color screens to display process variables, valve positions, startup sequences, and other relevant data with drill down to helpful histories and trends. Operating screens shall have a touch sensitive screen point to select the start sequence of the blowers, a touch sensitive screen point for pressure setpoint adjustment and the local/remote touch sensitive screen point for local or remote pressure or most open valve system control. The operation shall be programmed to be user friendly by providing sufficient prompting that an operator can intuitively follow through the commands to operate the blower system.

g. Displays and controls shall be provided to monitor all process variable input for master control and to monitor and modify setpoints, as required.

h. The monitor shall display screens identifying the blowers online including the lead blower and the ability to modify the lead blower selection.

i. The MCP shall have status indicators and alarm signals for each blower, similar to the Blower VCPs.

2. External signals from the MCP to each VCP shall be as follows:
   a. Blower start/stop signal.
   b. Increase airflow.
   c. Decrease airflow.

2.13 SURFACE PREPARATION AND SHOP PAINTING

A. All surfaces shall be prepared; shop primed and finish painted with two finish coats of Blower Manufacturer's standard coating system. Submit proposed coating system for Engineer's review and approval. All coating products shall be applied in strict accordance to manufacturer's recommendations.

B. Machine surfaces that are not painted shall be coated with a corrosion protective compound.

2.14 SOURCE QUALITY CONTROL

A. Each blower and drive motor shall be given a complete functional and performance test, witnessed by representatives of the Owner as specified in this Section and in accordance with Section 01756 - Commissioning.

B. All blower tests and the complete assembly tests shall be witnessed by four representatives of the Engineer and Owner. Costs of these tests, including travel and per diem, shall be included in the blower equipment price. Travel costs shall be assumed to originate at the Austin-Bergstrom International Airport. Provide 4 weeks prior notice, in writing, for the witnessing of tests.

C. Prior to conducting the tests, submit the proposed test procedure for review as required by PTC-10.

D. Upon completion of assembly, each blower, job motor or factory test motor, and oil lubrication skid shall be functionally tested at the place of assembly, witnessed by Engineer, with the LCP connected to all skidded instruments, electric valves, and appurtenances. Tests shall be conducted in accordance with the ASME Wire-To-Air Performance Test Code for Blower Systems, PTC 13 (2018). Tests may be conducted using the job motor or a factory test motor. In either case, a calibrated torque meter shall measure the gearbox/compressor shaft input hp as per Paragraph 4.35 of the Code. The test shall include determination of the surge line and verification of the guarantee points. Shaft power consumption shall include one operating oil pump. Testing using less accurate heat balance or measuring the wire power draw shall not be allowed. Compressor net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance. There shall be no other tolerances or measuring uncertainties used in reporting test results (i.e., the tests shall be reported with ± zero percent tolerance using the measured values). The witnessing Engineer shall sign each copy of the test data log sheet certifying that the required tests were performed in strict accordance with these specifications and the ASME PTC 13 Codes.
    1. The capacity of the blower shall be defined as per ASME PTC 13 Power Test Code. Specifically, capacity is defined as, "the net rate of flow compressed and delivered, expressed in terms of cubic feet per minute at the prevailing inlet temperature and pressure. It shall be measured in a suitable manner to exclude effectively all external leakage losses from sources such as shaft seals." That is, air flow shall be measured on the discharge side of the compressor at zero percent tolerance.
    2. All test equipment shall be calibrated and certified by an independent test agency no more than 12 months prior to the test date. Certificates shall show the stability of calibration over a period of at least 1 year per ISO 9001, Paragraph 4.11.
    3. Velocity vibration versus frequency levels shall be recorded within 10 1,000 and 10 10,000 Hz frequency range. Report vibration in velocity versus frequency; report to be as specified.
    4. The oil lubrication system shall be run and tested for leaks.
    5. All start/stop sequences and all safety and alarm systems shall be tested, simulating start of the blower motor. MCP shall be connected to all vendor panels.
    6. The entire system of all blowers, airflow control valves, vendor panels, and MCP, shall be demonstrated to the Witnessing Engineer as an operational system before shipment. The Witnessing Engineer shall sign the test procedure and results, certifying that the assembled blowers, auxiliaries, blow off, discharge, air flow control valves, and LCP are tested together, as a system, in the Blower Manufacturer’s shop.

E. The blower test report shall present computations in exact accordance with ASME PTC 13 Code with performance curves showing capacity, pressure, and hp inputs.

F. Test results of the motors and blowers shall be included in the Operations and Maintenance Manual.

PART 3 EXECUTION

3.01 INSTALLATION

A. The blowers, motors, all aeration instrumentation, and appurtenances shall be installed by the Contractor in accordance with the instructions of the Blower Manufacturer and as indicated on the Drawings. All piping shall be supported so as to preclude the possibility of exerting undue forces and movements on the blower flanges. Each blower unit shall be mounted on a flat and level concrete pad (±1/4 inch) in accordance with the recommendations of the Blower Manufacturer.

B. The Contractor shall furnish the required piping, pipe supports, flange gaskets, bolts, and nuts, oil, and grease for initial operation in accordance with the Blower Manufacturer's recommendations. Oil and grease for initial operation shall be supplied by blower manufacturer.

C. Start-up and training shall be completed as per Paragraph 3.03 for the aeration blowers. The main air header pressure transmitter shall be started up, and the system optimized for automatic, unattended operation. System time lags, speed of valve operation, fine tuning of control loops, and overall time lags shall all be set and optimized based on plant conditions. The entire system of aeration blowers, and main air header pressure control, shall be demonstrated to the satisfaction of the Engineer.

D. The process startup shall be executed in conjunction with Owner’s personnel to coordinate loop tuning activities so that the entire aeration system works in harmony.

3.02 FIELD TESTING

A. As specified in Section 01756 - Commissioning.

3.03 MANUFACTURER’S FIELD SERVICES

A. The Blower Manufacturer shall furnish experienced start-up service personnel to inspect the final installation and supervise the field start-up tests of the equipment and software. The services of the representative shall be provided for a minimum of four 8-hour days for each blower, and four 8-hour days for the MCP adjustment, and aeration system optimization. If there are difficulties in operation of the equipment due to the Blower Manufacturer’s fabrication and programming or Contractor's installation, additional service shall be provided at no extra cost to the Owner.
   1. Provide, as a minimum, the following field services: Provide written documentation for check out including who performed the work, when performed, the final setting or tolerance and who witnessed the final settings.
      a. Verify proper connection of piping and installation of accessories.
      b. Field precision alignment of the motor, blower, and coupling.

c. Check leveling of blower base.
d. Confirm proper wiring of all instruments and field wired items.
e. Run motor uncoupled for up to 1/2 hour to verify motor operation and check magnetic center for proper marking/location.

2. Provide technical services to support the Design-Builder and SCADA Subcontractor during temporary transition of using existing aeration blowers in combination with some new blower units, as necessary to maintain and assure reliable aeration system to the plant.
3. A minimum 4 hours, for each blower, field acceptance test shall demonstrate that, under all conditions of operation, each unit:
   a. Has not been damaged by transportation or installation.
   b. Has been properly installed.
   c. Has no mechanical defects.
   d. Has fully functional instrumentation which is properly calibrated and set.
   e. Will start, run, and stop in the prescribed manner.
   f. Will run through the entire range of specified pressure and flow.
   g. Has the proper shutdown sequence of standard stop, soft stop, and emergency stop.
   h. Is free of overheating of any parts.
   i. Is free of objectionable vibration and noise.
   j. Is free of overloading of any parts.
   k. Demonstrates the simultaneous and continuous efficiency optimization by altering the inlet guide vane position based on inlet temperature, differential pressure, and capacity.
4. A minimum 24 hours, for each blower, field acceptance test shall demonstrate that, under full load condition and sustained high ambient temperatures:
   a. Blower motor is free of high temperature motor overload.
5. Conduct a minimum of two-day field acceptance test of the aeration system instrumentation, controls, and valves. The test shall demonstrate the following:
   a. The air header pressure control loop will automatically control online blowers in a cascade mode of operation without hunting.
   b. The entire aeration system of blowers operates in a stable fashion, without hunting.
6. Field acceptance testing shall be conducted after the installation of all equipment has been completed and all instrumentation calibrated and working as intended and the equipment has operated for a sufficient period to make all desirable corrections and adjustments in accordance with the requirements specified. The Contractor shall schedule testing with the full knowledge and consent of the Owner and shall ensure no adverse effect on the operation of plant facilities.

B. The Blower Manufacturer shall furnish the services of the programmer responsible for programming the blower system, for troubleshooting the blower software programs to Engineer’s satisfaction as described herein. In addition, the Blower Manufacturer shall furnish the services of the programmer responsible for programming the blower system for four 4-hour days to program process and OIU modifications and optimization defined by the Owner during and after field acceptance testing and training.

C. Blower Manufacturer shall confirm scope of work and schedule with the Contractor and submit for Owner's and Engineer's review and approval. Unless other arrangements are made and after written approval from Owner, immediately prior to connection, Blower Manufacturer programmer shall e-mail Owner's designated Information Services process controls group representative or I&C Engineer and shall connect only after receiving approval to connect.

D. The Blower Manufacturer shall include an allowance to provide an experienced start-up/service factory representative. The field representative will be on-site to the satisfaction of the Engineer. As a minimum, the field representative will be onsite during the three phases of start-up and testing and in accordance with Section 15050 - Common Work Results for Mechanical Equipment as follows:
   1. Phase 1 – Start-Up: During this phase, the services of the representative shall be provided for a minimum of one trip and four 8-hour days.
   2. Phase 2 – 14-Day Operational Performance Test: During this phase, the services of the representative shall be provided for a minimum of two trips and four 8 hour days each trip.
   3. Phase 3 – Post Operational Performance Test: During this phase, the services of the representative shall be provided for a minimum of two trips and four 8 hour days each trip.

E. Training shall be included per Section 01756 - Commissioning and as specified herein. The Owner may video any and all training sessions for future use. Services/hours for training preparation, set-up and delivery are in addition to any other Manufacturer or motor representative services required in this specification.
   1. During control system development – provide control system overview training for Owner's Operation, Maintenance, and Information Services personnel. Coordinate with Information Services personnel to schedule with appropriate submittals.
      a. Provide a detailed syllabus and Trainer's credentials for Owner's review and approval per training requirements. The programmer responsible for blower and aeration control programming shall be present at the training sessions.
      b. As a minimum, cover planned OIU screens and planned information drill downs, Operator selections and adjustable setpoints on screens and via DCS, blower system monitoring and control; Maintenance screens; security.
   2. Immediately prior to blower start-up, provide blower training for Owner's Operation and (for general topics) Maintenance personnel. This training is to be concentrated on blowers and valves and maintenance operation and control of same, mainly at the LCP level.
      a. Provide a detailed syllabus and Trainer's credentials for Owner's review and approval per training requirements.
      b. Include instruction in blower, hands on demonstration of equipment functions and adjustment. Include control tuning, testing, preventive maintenance, example maintenance check list and where to find information on screens, explanation of why checked and what to do about it. Identify al safety requirements and safety procedures.
      c. Training shall incorporate real-time view and interface with Blower LCP with MCP and DCS screen examples (minimum) for illustration. Work with Owner's Information Services personnel prior to training to facilitate.

d. Provide two 1-hour repeat sessions on a 3 day mid-week (Tuesday to Thursday) period to cover personnel shifts and availability.

3. Immediately prior to blower start-up, provide blower training for Owner's Maintenance personnel. This training is to be concentrated on blowers and valves maintenance. Training for the blowers shall include blower system components including motors, oil lubrication system and air filtration system.
   a. Provide a detailed syllabus and Trainer's credentials for Owner's review and approval per training requirements.
   b. Include instruction in blower maintenance, hands on demonstration of equipment preventative and corrective maintenance and adjustments. Include overview of vibration monitoring system and response to alarm conditions. Note that the vibration monitoring system itself will have a separate training for Maintenance personnel. Include overview of O&M manual, preventive maintenance, and maintenance list. Include screens or trends that are designed to assist with Maintenance's blower condition check, problem identification and solving. Include testing. Identify all safety requirements and safety procedures.
   c. Training shall incorporate real-time view and interface with Blower LCP for illustration. Work with Owner's Information Services personnel prior to training to facilitate.
   d. Provide two 1-hour repeat sessions on a 3 day mid-week (Tuesday to Thursday) period to cover personnel shifts and availability.
4. After blower and aeration system control successful functional testing, provide blower and aeration system training for Owner's Operation and Maintenance and Information Services personnel. This training will concentrate on the LCP and interconnection with aeration system MCP control level.
   a. Provide a detailed syllabus and Trainer's credentials for Owner's review and approval per training requirements.
   b. Include instruction in theory of system operation, hands on demonstration of equipment functions and adjustment. Include tuning, testing, preventive maintenance, routine inspection and service procedures. Identify all safety requirements and safety procedures.
   c. Training shall incorporate real-time view and interface of aeration system MCP control screens. Work with Owner's Information Services personnel prior to training to facilitate.
   d. Provide two 2-hour repeat sessions on a 3 day mid-week (Tuesday to Thursday) period to cover personnel shifts and availability.
5. After Start-up, provide software trainings for Owner's Electrical Maintenance Technicians and Information Services Programmers.
   a. Provide detailed syllabus and Trainer's credentials for Owner's review and approval per training requirements.
   b. The training shall be led by the programmer responsible for blower and aeration system programming
   c. Divide the training into three 2-hour sessions to be conducted over a 9-day period. Note that the vibration monitoring system shall have a separate software training for Electrical Maintenance Technicians and Information Services programmers. Trainings will not be conducted on Monday or Friday.

END OF SECTION

[AD5] Addendum No. 5

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SECTION 11376A

ROTARY-LOBE BLOWERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Rotary-lobe blowers.

B. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Tag numbers:
   1. Rotary-lobe Blower No. 1: SHF-BLOWER-01.
   2. Rotary-lobe Blower No. 2: SHF-BLOWER-02.
   3. Rotary-lobe Blower No. 3: SHF-BLOWER-03.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   1. 52.1 - Testing for HVAC Air Filtration.

C. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

D. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4X enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. System components: Sludge holding tank blowers, blower panel, and appurtenances.

B. General: Sludge holding tank blowers and appurtenances shall include the following items and supplied by blower manufacturer:
   1. Rotary positive displacement blower and motor.
   2. Air intake filters.
   3. Silencers, inlet, discharge, and vent.
   4. Butterfly valves and silencer in blowoff circuit.
   5. Check valves.
   6. Relief valves.

7. Flexible pipe connectors.
8. Pressure gauges.
9. Acoustic enclosure.
10. Discharge temperature gauge.
11. Appurtenances as required.

C. Design requirements:

	Sludge Holding Tank No. 1	**Sludge Holding Tank No. 2**
Type of Blower	Rotary lobe, positive displacement	Rotary lobe, positive displacement
Number of blowers	2(1)	1
Rated speed, maximum	4,094 rpm	4,252 rpm
Rated inlet air flow at rated speed(2)	443 scfm	221 scfm
Required minimum airflow rate (Turndown speed)(3)	147.7 scfm	68.7 scfm
Inlet filter/Silencer pressure loss	0.5 pounds per square inch	0.5 pounds per square inch
Rated discharge pressure	22.09 psia	21.55 psia
Rated inlet pressure	14.45 psia	14.45 psia
Inlet temperature (F)	As specified in Section 01610	As specified in Section 01610
Site Elevation	As specified in Section 01610	As specified in Section 01610
Inlet relative humidity, average	67%	67%

1. Motor: As specified in Section 16222 - Low Voltage Motors up to 500 Horsepower, except as otherwise specified or supplemented below:

Power supply	480-volt, 3-phase, 60-hertz	480-volt, 3-phase, 60-hertz
Horsepower	30	15
Speed, maximum	1,800 rpm	3,530 rpm
Enclosure	TEFC	TEFC
Service factor	1.15	1.15

Notes:

1) Includes redundant blower that can be used to feed air to either Sludge Holding Tank No. 1 or Sludge Holding Tank No. 2.
2) Airflow determined by 30 scfm/kcf.
3) Airflow determined by 10 scfm/kcf.

2. Drive: Belt.
3. Noise control:
    a. Sound pressure levels radiated from equipment furnished shall not exceed 78 dBA (mean, A-weighted) at 3 feet (RE 2 x 10^{-5} N/m^2) for free field condition when unit is in operation at rated flow.
4. Vibration:
    a. Maximum acceptable peak vibration velocity (unfiltered) for blower equipment is 0.45 inches per second.
5. Variable Frequency Drive: As specified in Section 16483.
6. Provide control panel, instrumentation, and alarms as indicated on the P&ID Drawings and as specified in Sections 17100 - Process Instrumentation and Control Systems (PICS) and 17101 - Specific Control Strategies.

D. System operation: System operation shall be as specified in Sections 17100 – Process Instrumentation and Control Systems (PICS), and 17101 - Specific Control Strategies.

1.05 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data:
1. As specified in Section 15050 - Common Work Results for Mechanical Equipment.
2. Blower information:
    a. Manufacturer.
    b. Model.
    c. Blower speed in revolutions per minute.
    d. Blower site capacity, actual cubic feet per minute.
    e. Discharge pressure, pounds per square inch absolute.
    f. Horsepower required including loss in V-belt drive.
    g. Weight of blower.
    h. Weight of motor.
    i. Free-field noise level at 3 feet from blower acoustic enclosure.
3. Motor performance and construction data.
4. Construction details of acoustic enclosure.
5. Descriptive brochures and applicable performance and construction data for each item of auxiliary equipment along with their weights.
6. Certified test data on equipment performance, vibration, and noise. Certification shall be by an authorized representative of the blower manufacturer.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
1. Blower panel device layout and material list.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Vendor operation and maintenance manuals: As specified in Section 01730 - Operation and Maintenance Manuals.

F. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.06 ENVIRONMENTAL CONDITIONS

A. Blower shall be suitable for continuous service and outdoor installation.

B. Site conditions are as specified in Section 01610 – Project Design Criteria.

1.07 WARRANTY

A. Provide 2 year warranty in accordance with 00700 – General Conditions and this section. Wherever there is a conflict, the most stringent requirement shall apply.

B. Warrant that equipment is free of defects in materials and workmanship for a minimum period of 2 years following issuance of substantial completion. Warranty shall cover travel, shipping, parts and labor at no cost to the OWNER.

PART 2 PRODUCTS

2.01 AERATION BLOWERS

A. Manufacturers: One of the following or equal:
   1. Aerzen, Model GM.
   2. Roots, Model URAI.
   3. Gardner Denver Sutorbilt blower, 4500 and Legend series.
   4. Kaeser Compressors.

2.02 MATERIALS

A. General:
   1. Sludge holding tank blower assembly: Complete with blower, drive, inlet and discharge silencers, valves, and appurtenances.
   2. Blower rating: As specified above.
   3. Rotation direction of blower shall match requirements of piping.

B. Blower and drive:
   1. General:
      a. Blower shall deliver oil-free air.
      b. Blower and motor mounting: On common base.
      c. Lifting provisions: Lifting eyes on blowers, motors, and base so each major component or entire unit can be lifted.
      d. Piping connections: 125 pound class flanges in accordance with ASME B16.1.

e. Motors driven by VFD shall be installed with shaft grounding ring. Shaft grounding ring shall have an aluminum frame and internal components. Design shall be maintenance free and have conductive microfiber brushes.
   1) Manufacturer: Electro Static Technology, Aegis Bearing Protection ring or equal.

2. Type: Positive displacement rotary blowers using 2 impellers to pressurize a trapped volume of air at a controlled rate prior to exposing it to a discharge pressure.
3. Casing and head plates:
   a. Blower casing: 1 piece with separate head plates and end covers.
   b. Casing and head plates: Made of close-grained, machined cast iron.
   c. End covers and head plates: Reinforced with bosses at penetrations with cast, machined support feet.
4. Impellers:
   a. Material: Ductile iron or cast iron.
   b. Design: Straight, ~~2~~tri-lobe, involute type. AD2
   c. Balance: Dynamically, by removing metal from impeller body.
   d. Operation: Free of rubbing without need for liquid seals or lubrication.
   e. Timing: positively by a pair of accurately machined, heat-treated, alloy steel timing gears.
   f. Shafts: Alloy steel forgings, pressed into each end of each impeller and pinned.
   g. Impeller assembly support: Anti-friction type bearings, sized for a minimum ABMA 9 and 11 L10 life for bearings of 100,000 hours.
5. Lubrication:
   a. Positive oil seal: Provided at each bearing.
   b. Seal design: Capable of preventing lubricant from leaking into air stream.
   c. Vent provisions: Capable of venting impeller side of oil seal to atmosphere while eliminating possible carryover of lubricant into air stream.
   d. Drive-end bearings: Grease or oil lubricated.
   e. Timing gears and gear-end bearings: Splash oil lubricated.
   f. Blower's shipment: With openings sealed after injection of rust inhibitor.

2.03 APPURTENANCES

A. Inlet filter shall have front access for filter element access. Filter shall provide 99 percent removed efficiency of 5 micron particle size and larger.

B. Silencers:
   1. Manufacturers: The following or equal:
      a. Burgess-Manning, Model BMSI, BMSS, or equal.
      b. Aerzen, equivalent product.
      c. Howden Roots, equivalent product.
      d. Gardner Denver, equivalent product.
   2. Construction: Welded steel.
   3. Discharge silencer: Furnished with copper wool absorption material and shall have connections for a pressure relief valve, pressure gauge, temperature gauge, and drain.
   4. Silencers sizing: For design conditions and specifically designed for use with positive displacement blowers, size as indicated on the Drawings unless a larger size is recommended by the manufacturer.

5. Mounting of silencers: Inside the acoustic enclosure and per manufacturer.
6. Noise attenuation of silencers shall as a minimum, meet the following:

Octave Band Center Frequency, hertz	Attenuation, dBA
63	12
125	20
250	27
500	30
1,000	31
2,000	29
4,000	25
8,000	21

C. Acoustic enclosure:
   1. Galvanized sheet-metal sandwich construction.
   2. With noise attenuating walls and with ventilation openings ported, ducted, shielded, and lined with acoustic absorptive material as required to achieve specified noise levels.
   3. Design criteria:
      a. Seismic: As specified in Section 01612 - Seismic Design Criteria.
      b. Wind: As specified in Section 01614 - Wind Design Criteria.
   4. Raintight and dusttight, suitable for outdoor unprotected installation.
   5. With ventilation system designed for sufficient heat removal from the sound enclosure even when operating a VFD at all speeds The fan motor shall be prewired into a separate junction box that is interlocked with blower motor to start when blower starts and which will not allow the main drive motor to start if the cooling fan motor doesn't start. Fan to stop with an adjustable time delay after the blower motor stops.
   6. With a weather-protected ventilation air intake filter:
      a. Of disposable, dry type, pleated lofted cotton and polyester fiber media construction, securely bonded to a welded galvanized wire backing, with a frame of heavy-duty paperboard.
      b. Sized for not more than 400 feet per minute face velocity.
      c. With ASHRAE Standard 52.1 cleaning efficiency of not less than 25 percent.
      d. With thickness not less than 1 inches.
      e. With an easily visible and resettable "replace filter" indicator with retained indication independent of blower on/off status.
   7. With removable access panels located for maintenance and inspection access to the housed equipment, each weighing not more than 40 pounds, or hinged if weight exceeds 40 pounds.

D. Relief valve: High-capacity, full-nozzle type; 2 inch minimum valve inlet:
   1. Manufacturers: The following or equal:
      a. Kunkle Valve Co.

E. Butterfly valves:
   1. Constructed as specified in Sections 13446 - Manual Actuators and 15112 - Butterfly Valves.
   2. Lined with 10 mils of epoxy suitable for temperatures to 350 degrees Fahrenheit.
   3. Sealed with seals suitable for temperatures of 350 degrees Fahrenheit.

F. Check valves: No. 8808-GAX-SSF; dual disc, wafer style with torsion spring induced closure:
   1. Manufacturers: The following or equal:
      a. Val-Matic.
   2. Consisting of following components:
      a. Valve body: ASTM A126 cast iron.
      b. Disc: ASTM B148-9A, aluminum bronze.
      c. Spring: ASTM A276, Type 316 stainless steel.
      d. Pins and thrust bearings: ASTM A276 Type 316, stainless steel.
      e. Seals, rated for minimum 350 degrees Fahrenheit.

G. Pressure gauges: Liquid filled case with minimum 2 1/2 inch dial face:
   1. Type on suction side of blower: Vacuum gauge calibrated in inches of water.
   2. Type on discharge side of blower: Pressure gauge calibrated in pounds per square inch gauge.
   3. A suitable tee handled corporation stop or ball valve and snubber shall be installed between each gauge and connection to air piping.
   4.

H. Sensors:
   1. Discharge Air Temperature Element:
      a. With thermowell, suitable for mounting in discharge piping of enclosure.
      b. Range of 0 to 300 degrees Fahrenheit or as recommended by blower manufacturer.
      c. With local and remote indication of temperature.
      d. Provide operator adjustable alarm and shutdown set points with intitial settings recommended by manufacturer.
   2. Enclosure air temperature element:
      a. With thermowell, suitable for mounting in enclosure.
      b. Range of 0 to 300 degrees Fahrenheit or as recommended by blower manufacturer.
      c. Local indication of temperature.
      d. Provide operator adjustable alarm and shutdown setpoints with initial settings recommended by manufacturer.

I. Other safety devices and controls: As recommended by blower manufacturer.

J. Rubber expansion joints:
   1. Provided at inlet and discharge flanges of blowers.
   2. Suitable for pressures up to 15 pounds per square inch gauge and temperature up to 350 degrees Fahrenheit.
   3. At discharge joints, provided with control rods to restrict axial pipe movement.
   4. Manufacturers: The following or equal:
      a. General Rubber.
   5. Expansion joints outside acoustic enclosure shall be supplied by contractor.

K. Supports and bracing: As required to support blower, associated equipment and piping, and to prevent excessive or harmful vibration or movement of equipment or piping.

2.04 CONTROLS

A. Blower control strategy: As specified in Section 17101 – Specific Control Strategies.

B. Enclosure: As specified in Section 17200 – Instrumentation and Control Cabinets and Associated Equipment for factory-wired controllers and monitoring for blowers.

C. Components: Include provisions for start/stop push buttons, selector switches, indicating lights, annunciators, and other devices for alarm and shutdown systems.

D. Mounting position of vibration and temperature switches: As recommended by manufacturer of sensing equipment to provide maximum protection.

2.05 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: Provide the following:
   1. 1 complete set of bearings.
   2. 4 complete sets of ventilation and air intake filters.
   3. 4 lubrication oil filter cartridges.
   4. 2 complete sets of gaskets and o-rings.
   5. 2 sets of drive belts:
      a. Label spare parts as specified in Section 01600 - Product Requirements and box for storage.

B. Special tools: Provide the following:
   1. 1 set of special tools with equipment when required for normal operation and maintenance.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install adequate supports and bracing to support blower, associated equipment and piping, and to prevent excessive or harmful vibration or movement of equipment or piping resulting from operation of the system.

B. Mount blower on base plate: Properly align and grout base plate as required for blower and base for electric motor with sliding rails.

C. Secure silencers with hold-down bolts.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning, 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 2-day minimum.
      b. Functional Testing: 2 trips, 1-day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing:
   1. Test as specified in Section 15958 - Mechanical Equipment Testing.
   2. Blower:
      a. Test witnessing: Not witnessed.
      b. Conduct Level 1 General Equipment Performance Test.
      c. Conduct Level 1 Vibration Test.
   3. Electrical and Controls:
      a. Conduct testing as specified in Section 16800 – Calibrations, Testing and Settings and 17100 Process Instrumentation and Control Systems (PICS).

D. Functional testing:
   1. Electrical and Controls:
      a. Conduct testing as specified in Section 16800 – Calibrations, Testing and Settings and 17100 Process Instrumentation and Control Systems (PICS).
   2. Rotary Lobe Blower System:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test.
      c. Conduct Level 2 Vibration Test.
      d. Conduct Level 2 Noise Test.

END OF SECTION

[AD2] Addendum No. 2

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SECTION 11377A

COARSE BUBBLE DIFFUSERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wide-band stainless steel coarse bubble air diffusers.

1.02 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment:

C. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Head loss curves for diffusers as detailed in this Section.

D. Vendor operation and maintenance manuals: As specified in Section 01730 - Operation and Maintenance Manuals.

E. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.03 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or engineer approved equal:
   1. Sanitaire.
   2. Aquarius.
   3. SSI Aeration Inc.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. Air release:
   1. Distributed along the diffuser uniformly at air rates from 10 to 40 standard cubic feet per minute with no disproportionate airflow from any single point.

B. Orifice insert to operate at the following maximum head losses:
   1. Head loss shall be measured in from the connector to the water at the specified airflow rates:

Diffuser Location	Diffuser Length	Flow Rate per Linear Foot	Head Loss Per Diffuser
Aeration Basin Effluent Channel for AB 3&4.	24 inches	5 scfm/linear ft	4 inches of water column

C. The coarse bubble diffusers shall pull air off the main aeration basin blower header. The fine bubble diffusers will also pull off this header. Refer to 11378A for fine bubble diffuser requirements. Refer to Drawings for coarse bubble diffusers manufacturer piping and diffuser responsibilities.

D. Diffuser manufacturer shall provide an orifice insert for the coarse bubble diffuser header for the effluent channels of Aeration Basins No. 1 & 2 and Aeration Basins No. 3 & 4, as shown on Drawings. Orifice shall be design to maintain a steady, desired airflow through the coarse bubble diffuser system as the pressure in the main air header varies. Air flow through coarse bubble system shall not vary by more than 10% as the main air header pressure fluctuates between 7.3 psig and 8.5 psig.

2.03 MATERIALS

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Components:
   1. Aeration Component: 20 gauge Type 304L stainless steel.
      a. Provides air reservoir with air exit ports along both sides.
   2. Bottom Component: 20 gauge Type 304L stainless steel.
      a. Deflects deleterious material liquid.
   3. End caps: Cast stainless steel.
   4. Male connector: Stainless steel schedule 80 pipe with 3/4 inch NPT and hex nut base.
      a. Maintain flexural resistance characteristics with diffuser connectors in place when subjected to a moment of 500-inch pounds at the diffuser connector.

C. Welding:
   1. Perform all diffuser and diffuser connector welding operations at factory during fabrication.

D. Corrosion protection and finishing:
   1. Equipment manufacturer shall notify Engineer in writing at least 2 weeks prior to pickling operation so that Engineer may attend and observe procedure.

2.04 SPARE PARTS

A. Provide the following spare parts:
   1. 10 percent of the total coarse air bubble diffusers utilized on the project.

PART 3 EXECUTION

3.01 INSTALLATION

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Leveling:
   1. After installation, level diffusers to within 1/4 inch of a common horizontal plane.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 2 trip, 1-day minimum.
      b. Functional Testing: 1 trip, 1-day minimum each.
   3. Training:
      a. Maintenance: 1 hours per session, 2 sessions.
      b. Operation: 1 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Functional testing:
   1. Test witnessing: Witnessed.
   2. Airtightness:
      a. After completion of the installation of the aeration system, fill basin to a level approximately 2 inches above the diffusers and check operation by introducing air into system.

END OF SECTION

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SECTION 11378A

FINE BUBBLE DIFFUSED AERATION SYSTEM - DISK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Membrane disk fine bubble diffused aeration system.

B. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Tag numbers:
   1. Aeration System (4 Identical basins)
      a. Aeration Zone 5.
      b. Aeration Zone 6.
   2. Sludge Holding Tank No. 1, SHF-SLUDGEBASIN-01.
   3. Sludge Holding Tank No. 2, DIG-SLUDGEBASIN-01.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 2-91 - Measurement of Oxygen Transfer in Clean Water.

B. ASTM International (ASTM):
   1. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Application.
   2. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   3. A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   4. A530 - Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
   5. A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
   6. A774 - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
   7. A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
   8. D395 - Standard Test methods for Rubber Property - Compression Set.
   9. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   10. D573 - Standard Test Method for Rubber - Deterioration in an Air Oven.
   11. D1171 - Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
   12. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   13. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
   14. D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

15. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
16. D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
17. D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) PVC Sewer Pipe and Fittings.

1.03 DEFINITIONS

A. SOTR: Standard Oxygen Transfer Rate, expressed as pounds of oxygen per day; the rate of transfer of oxygen from air into tap water at standard conditions of temperature (20 degrees Celsius) and pressure (1 atmosphere), with zero dissolved oxygen concentration.

B. SOTE: Standard Oxygen Transfer Efficiency, expressed as a percentage; the efficiency of oxygen transfer under standard conditions (20 degrees Celsius, 1 atmosphere), determined as the fraction of oxygen in an injected gas stream dissolved under standard conditions.

C. DO: Dissolved Oxygen concentration in the mixed liquor, in milligrams per liter (mg/L).

D. MLSS: Mixed liquor suspended solids concentration, in mg/L.

E. Zone: Section or compartment of each aeration basin that contains at least 1 individual diffuser grid and aeration air dropleg, as indicated on the Drawings.

1.04 SYSTEM DESCRIPTION

A. System location: Activated sludge aeration basins and sludge holding tanks**.**

B. System components: Includes, but not limited to:
   1. Air distribution piping (including droplegs, manifolds, and laterals).
   2. Piping supports.
   3. Air diffuser assembly (including membrane diffuser element, baseplate, diffuser holder, retainer ring, and airflow control orifice).
   4. Moisture blow-off system.
   5. Fasteners and hardware.

C. System configuration:
   1. 2 existing aeration basin trains that have been modified with layout and dimensions as indicated on the Drawings. Oxic zones include Zone 5 and Zone 6 as indicated on the Drawings and as specified.
   2. 2 new aeration basin trains with layout and dimensions as indicated on the Drawings. Oxic zones include Zone 5 and Zone 6 as indicated on the Drawings and as specified.
   3. 1 existing sludge holding tank with layout and dimensions as indicated on the Drawings and as specified.

4. 1 new sludge holding tank with layout and dimensions as indicated on the Drawings and as specified.
5. Nominal basin dimensions, including side water depths in units of feet of water for each zone at different operating conditions, are indicated below:

Zone	Length (ft)	Width (ft)	Side Water Depth (ft)		
			Minimum	Average	Peak
Aeration Basin					
Zone 5	28	30.0	16.76	16.86	16.9
Zone 6	28	30.0	16.76	16.86	16.9
Sludge Holding Tank (SHT)					
SHT No. 1 (New)	35 ft diameter		4	15.35	15.35
SHT No. 2 (Existing)	25 ft diameter		4	14.00	14.00

D. Design requirements:
   1. Aeration Basin System: General:
      a. The fine bubble diffused aeration system furnished under this Section is designed to supply the aeration required to maintain a DO concentration of 2.0 mg/L in each aeration basin, and to maintain suspension of a mixed liquor with a MLSS concentration ranging from 1,500 to 3,500 mg/L.
      b. The airflow to the fine bubble diffused aeration system will be supplied by centrifugal blowers and the airflow rate varied independently to maintain the desired DO concentration in the mixed liquor.
   2. Sludge Holding Tank System: General:
      a. The fine bubble diffused aeration system furnished under this Section is designed to mix the contents of the sludge holding tank and maintain a DO concentration of 1.0 mg/L in each sludge holding tank.
         1) Total solids concentrations in the Sludge Holding Tank No. 1 are expected to range between 0.5 percent and 2.0 percent.
         2) Total solids concentrations in the Sludge Holding Tank No. 2 are expected to range between 1.0 percent and 3.0 percent.
      b. The airflow to the fine bubble diffused sludge holding system will be supplied by positive displacement blowers and the airflow rate will vary with side water depth to maintain the desired volumetric aeration rate. The blowers will constantly operate and airflow rate will range between 10 and 30 scfm per 1,000 cubic feet of sludge based on operator setpoint.
   3. Mechanical:
      a. The fine bubble diffused aeration system includes the air distribution piping (droplegs, manifolds, and laterals), piping supports, the air diffuser assemblies (diffuser disks, baseplates, diffuser holders, retainer rings, and flow control orifices), the moisture blow-off system, fasteners, hardware, and all accessories required for a complete installation and as required by the performance requirements in this Section.
      b. The aeration system shall be compatible with hydrochloric acid, formic acid, and hydrogen chloride gas.

c. Joints in the aeration system piping which are factory solvent welded shall conform to the standard practice described in accordance with ASTM D2855.
d. PVC solvent cement shall conform to all requirements in accordance with ASTM D2564.

4. Operating parameters:
   a. Process airflows: Process airflows, in units of standard cubic feet per minute (scfm), for each zone at different operating conditions are indicated below:

Zone	Operating Condition		
	Minimum	**Average**	**Peak**
Aeration Basin			
Zone 5	166	331	744
Zone 6	81	160	236
Sludge Holding Tank (SHT)(1)			
SHT No. 1	75	222	443
SHT No. 2	35	118	208

Notes:
(1) Based on mixing limited conditions.

   b. Maximum allowable pressure in the air piping at the dropleg connection for any of the specified conditions shall not exceed:
      1) Aeration basin Zone 5 & Zone 6: 9.50 pounds per square inch gauge.
      2) Sludge Holding Tank No. 1: 7.65 pounds per square inch gauge.
      3) Sludge Holding Tank No. 2: 7.50 pounds per square inch gauge.
   c. System to be designed to withstand the maximum allowable pressure plus a surge factor of 1.25.
   d. Air temperature at dropleg during operation: ambient to 250 degrees Fahrenheit.

5. Diffuser layout:
   a. Provide manifolds, laterals, and diffusers as indicated on the Drawings and as required by the performance requirements in this Section.
   b. Provide diffuser quantities as required to meet performance requirements specified.
   c. The diffuser layout shall be subject to the approval of the Engineer. The Engineer shall determine compliance with the stated requirements.
   d. Design the diffuser grid layout to satisfy the following minimum requirements:
      1) Minimum clearance of 12 inches from any wall to edge of diffuser.
      2) Maximum clearance of 36 inches from any wall to edge of diffuser.
      3) A minimum clear spacing of 2 inches between adjacent diffusers (including blank diffusers) on the same lateral.
      4) A maximum clear spacing of 48 inches between adjacent diffusers (including blank diffusers) on the same lateral.
      5) A minimum clear spacing of 6 inches between diffusers (including blank diffusers) on adjacent laterals.

6) A maximum clear spacing of 48 inches between diffusers (including blank diffusers) on adjacent laterals.
7) Make provisions for ladder placement to allow entry into each zone from the top of the basin.
8) Access-ways shall be provided between groups of laterals and have a minimum clear spacing of 24 inches (edge-to-edge) between diffusers. Sufficient clearance shall be provided to move from one access-way to another.
9) It shall not be necessary for a person to reach across more than 1 diffuser lateral to access any diffuser from an access-way; therefore, no more than 4 laterals may be placed in a group between access-ways and no more than 2 laterals between a wall and the first access way.
10) All laterals in a diffuser grid shall be cross-connected at their far ends, away from the points of air supply, to facilitate air balancing and moisture blow-off.

e. Droplegs:
1) A fixed number of droplegs on the main air header piping have been provided and additional droplegs are not available.
2) The location of these droplegs is fixed and changes in dropleg location are not allowed unless approved in writing by the Engineer.
3) The diffuser manufacturer shall refer to the grid layout and dropleg locations indicated on the Drawings during design of the diffuser system.

f. Sludge Holding Tank: Include additional submerged piping as part of the diffuser layout as required to provide cooling of air and to prevent exceeding maximum recommended diffuser membrane and piping system operating temperatures at all specified side water depths.

E. Performance requirements:
1. System performance requirements (minimum) are as follows:

Zone	Peak AD2 SOTR, lbs/day	SOTE, %	Peak AD2 Airflow Rate, scfm	Minimum Active Diffuser Count	Number of Blank Diffusers, %
Aeration Basin					
Zone 5	~~2,753~~5,674 AD2	32.9	744	280	10
Zone 6	~~1,235~~1,738 AD2	30.5	236	146	10
Sludge Holding Tank (1)					
SHT No. 1	--	--	443	224	5
SHT No. 2	--	--	221	124	5

Notes:
(1) Based on mixing limited conditions.

2. Demonstrate compliance with the minimum SOTE requirements specified above through a Factory Standard Oxygen Transfer Test:
a. The Test shall be based on the Zone 5 configuration specified above.

b. Additional diffuser requirements for the remaining zones shall be determined by proration of the Test Zone results based on the estimated active diffusers specified for each zone:
    1) The estimated active diffuser counts specified in the preceding table are included solely for the purposes of this proration.
    2) Actual active diffuser requirements may be higher or lower depending on the results of the Factory Test.
c. If the Factory Test determines that the specified minimum SOTE for the Test Zone can only be achieved by using more diffusers than estimated above for the Test Zone, then the active diffuser count in each of the other zones shall be proportionately increased over their respective estimated active diffuser counts.
d. In no case shall the diffuser count in each zone be less than the counts listed in the tables above.

3. Provide a minimum number of blank diffuser assemblies as indicated in the table above. The number of blank diffusers assemblies required is specified as a percentage of the active diffuser assemblies.
4. Size dropleg, manifolds, and lateral piping as required to provide air distribution uniformity values in each zone as follows:
    a. 98 percent at average conditions.
    b. 95 percent at peak conditions.

1.05 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
1. Descriptive literature and dimensional drawings for all equipment proposed, including views of the air manifold and diffuser assemblies indicating materials of construction, material product specification for all components, and number, location, and spacing of diffusers, and size and layout of air piping:
    a. Include weights, center of gravity, and lifting diagrams, as required.
2. Pipe support layout describing methods for supporting and preventing uncontrolled movement of the air manifold and diffuser lateral grid pipe resulting from flotation dynamic forces, thermal expansion, fluid forces developed by mixers and flow from process pipe inlets/outlets forces, and other external forces.
3. Methods for compensating for thermal expansion and construction and design criteria employed.
4. Methods for draining the air distribution systems.
5. Air diffuser assemblies:
    a. Number of diffuser elements.
    b. Complete materials list, material specifications, dimensions, and tolerances of all parts of the diffuser assemblies.
    c. Curve showing head loss versus airflow rate for the flow control orifice and diffuser element.
    d. Testing and sampling plans for Source Quality Control of the diffuser elements.
    e. A full-size, completely assembled, representative sample of the proposed diffuser assembly, mounted on 4-inch PVC pipe, including diffuser, gaskets, element holder, retaining ring, pipe supports, and expansion joint on 1 end, and all appurtenances for the particular diffuser system.

6. Diffuser grid piping:
    a. Complete materials list and specifications, dimensions, critical tolerances of piping, fittings, expansion joints, and accessories.
    b. Layout of grid piping, diffuser holders, expansion joints, and pipe supports.
    c. Identification of the installed location of the solvent welded pipe.
7. Manifold piping:
    a. Complete material list, material specifications, dimensions, thickness of piping, fittings, expansion joints, and accessories.
    b. Layout of air manifolds.
8. Pipe supports:
    a. Complete design criteria, material list, material specifications, and dimensions of all parts of the pipe supports and extensions.
    b. Include drawings showing proposed support design including anchor locations and details.
    c. Include calculations for supports for thermal expansion in air from 30 degrees Fahrenheit to 95 degrees Fahrenheit.
9. Moisture blow-off systems:
    a. Complete materials list, material specifications, and dimensions of all parts of the system.
    b. Location of the system and layout of the piping, including joints, pipe supports, and valves.
    c. Specifications for the ball valve.
10. Certification that special shipping and storage containers shall be utilized to protect the material from sun deterioration, handling damage, and heat warpage.
11. Packing, shipping, and storage procedures.
12. Air manifold piping factory leak test certification:
    a. Certification that air manifold piping has successfully passed the leak test specified in air manifold piping testing.
    b. Submit this certification prior to shipment.
13. Spare parts list.
14. Provide membrane longevity test reports:
15. Factory Standard Oxygen Testing Results.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
    1. As-built set of diffuser drawings:
        a. A maximum of 30 days following the successful completion of the field 7-day test, provide an as-built set of diffuser drawings showing the installed diffuser configuration with all pertinent details including:
            1) Installed number and location of diffusers and droplegs.
            2) Installed configuration of the air distribution piping including valves and fittings, the location of the access ways.
            3) Location of the moisture blow-off piping.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
    1. Certified efficiency curve:
        a. Curve of SOTE versus air flux rate (defined as airflow in scfm per active diffuser area) at the design submergence, prepared, sealed, and signed by a registered professional Engineer.

2. Design calculations:
    a. Design calculations documenting air head loss from the top of the dropleg to the farthest diffuser for all conditions specified in System Description.
    b. Design calculations verifying uniform air distribution through the manifold header and diffusers under all conditions specified in System Description.
    c. Design calculations showing loading conditions on piping and support components. Include fluid forces developed by mixers and flow from process pipe inlets/outlets.
    d. Design calculations showing mechanical strength capabilities of diffuser mounting system.
    e. Design calculations showing normal buoyancy uplift forces and structural calculations to meet the requirements of piping supports.
    f. Design calculations for piping supports for thermal expansion in air from 30 degrees Fahrenheit to 95 degrees Fahrenheit.
    g. Calculations demonstrating adequacy of submerged stainless steel cooling piping to provide necessary cooling of airflow to diffusers.

E. Vendor operation and maintenance manuals: As specified in Section 01730 - Operation and Maintenance Manuals.

F. Commissioning submittals:
    1. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning:
    2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.06 PROJECT CONDITIONS

A. Environmental project conditions:
    1. Exposure to industrial solvents and petroleum products.
    2. Intermittently submerged and exposed to atmosphere.
    3. Wastewater temperatures:
        a. Maximum: 100 degrees Fahrenheit.
        b. Minimum: 60 degrees Fahrenheit.

1.07 DELIVERY

A. Manufacturer shall fabricate and deliver materials to the job site in conformance with the Contractor's construction schedule, to minimize handling and on-site storage of equipment.

B. Materials shall be unloaded directly into the aeration basins and covered in accordance with the manufacturer's recommendations. Covering system shall protect the materials from UV radiation.

1.08 STORAGE AND PROTECTION

A. Protect the system components at the site and during installation prior to project completion.

B. As a minimum, provide cover, ventilation, and proper stacking to prevent warping of all aeration system piping stored on-site.

1.09 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

B. Special warranty:
   1. Duration: Provide 3-year warranty on all parts and materials:
      a. The extended warranty shall provide for replacement of all membranes which physically fail, tear, or pull out of mounting systems during operation.
   2. Warranty shall commence upon final acceptance of the aeration system by the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Furnish complete fine bubble aeration system by following manufacturer, or engineer approved equal:
   1. Sanitaire manufactured by ITT Industries, Inc.
   2. SSI Aeration Inc.
   3. Environmental Dynamics International (EDI)

B. The complete fine bubble aeration system shall be furnished by a single manufacturer who is fully experienced in the design and manufacture of such equipment.

C. Use identical diffusers of the same model, type, and manufacturer, throughout the installation.

2.02 MATERIALS

A. General: For all components except where specifically modified in Equipment, use the materials of construction specified below:
   1. Stainless steel:
      a. Fabricate all welded parts and assemblies from sheets and plates of Type 304L stainless steel in accordance with ASTM A240 with a No. 2D finish in accordance with ASTM A480. Welds in accordance with ASTM A774.
      b. Fabricate all non-welded parts and assemblies from sheets and plates of Type 304 stainless steel in accordance with ASTM A240, with a No. 2D finish in accordance with ASTM A480.
      c. Use Type 304L stainless steel in accordance with ASTM A240 in the fabrication of all stainless steel pipe. In accordance with ASTM A530, ASTM A554, and ASTM A778 in the fabrication of all stainless steel pipe.
      d. Use Type 304L stainless steel in accordance with ASTM A240 in the fabrication of all stainless steel pipefittings. In accordance with ASTM A774 in the fabrication of all stainless steel pipefittings.
      e. Use Type 304 stainless steel in accordance with ASTM A240 in the fabrication of all stainless steel bolts, nuts, and washers.
      f. Pickle all stainless steel assemblies and parts after welding, fabrication, and wire brushing by complete immersion in an acid solution in accordance with ASTM A380:

1) Corrosion protection techniques not employing full immersion methods shall not be acceptable.

g. Do not field weld any stainless steel pipe, fittings, fabrications or assemblies.

2. PVC:
   a. Fabricate all PVC moldings and extrusions from PVC compound in accordance with ASTM D1784, cell classification 12454-B.
   b. Fabricate all PVC droplegs, manifolds, piping from PVC material in accordance with ASTM D2241, with a hydrostatic design stress of 2,000 pounds per square inch.
   c. Use PVC pipefittings in accordance with ASTM D3034.
   d. Add a minimum of 2 percent titanium dioxide to all PVC compounds.
   e. Shop fabricate all solvent welded PVC joints in accordance with ASTM D2855.
3. Membranes:
   a. Manufacture all membranes of EPDM synthetic rubber compound with precision die formed slits.
   b. Do not use thermoplastic materials such as plasticized PVC or polyurethane.
   c. The EPDM rubber compound shall be tested by a certified laboratory and have the following characteristics:

Parameter	**Standard**	**Value / Unit**
Base Compound		EPDM w/ Carbon Black for UV Protection
Tensile Strength (Unperforated)	ASTM D412	1,200 psi
Elongation at Break	ASTM D412	350 percent
Hardness (Durometer)	ASTM D2240	58 within 5, Shore A
Accelerated Aging		
Compression Set	ASTM D395	
@ 23 degree Celsius, 22 hours		20 percent
@ 70 degree Celsius, 22 hours		40 percent
Elongation (percent retained)	ASTM D573	
@ 100 degree Celsius, 70 hours		75 percent
Ozone Resistance	ASTM D1171	Pass
Modulus of Elongation @ 300 percent	ASTM D412	500 psi
Material Thickness		0.08 inches

2.03 EQUIPMENT

A. General:
   1. As specified in Section 01600 - Product Requirements.
   2. Supply products that are units of the manufacturer's standard production, modified as necessary to satisfy the requirements of the Contract Documents, and specially fabricated for this project. Do not use products manufactured for another project.
   3. The manufacturer shall supply a complete fine bubble diffuser system, ready for installation by the Contractor. No field modification of headers or field drilling or threading of headers shall be required.
   4. Contractor shall provide all valves, air main piping, wall sleeves with seals, wall pipes, and concrete pedestals as necessary to complete the system as shown on the plans.
   5. All equipment and appurtenances shall comply with the requirements of the building code:
      a. Design mechanical equipment and piping and their supports to prevent sliding or overturning.
      b. Provide brackets and anchors of ductile material capable of absorbing energy and continuing to carry load.

B. Air distribution piping:
   1. General:
      a. The air distribution piping includes the droplegs into the aeration basin, the manifolds that supply air from the dropleg to the laterals, and the laterals on which the diffusers are mounted.
      b. Use only stainless steel or PVC for all air distribution piping as specified in the Drawings.
      c. Account for stresses due to temperature variation and provide suitable systems to permit non-destructive relief of piping stresses.
      d. Install piping plumb with walls and make up all changes in direction using standard fittings.
      e. Fabricate all piping assemblies to be field installed using flange-type joints or positive fixed threaded union joints:
         1) Push on, bell in spigot, or expansion type joints will not be acceptable.
      f. Field welding of pipe sections, fittings, or flanges is not acceptable.
   2. Joints:
      a. Threaded union joints shall consist of a spigot section solvent welded to 1 end of the pipe, a threaded socket section solvent welded to the mating pipe, an O-ring gasket, and a threaded screw on a retainer ring.
      b. Positive fixed threaded union joints shall also have a spline and groove feature that will prevent rotation of adjacent header sections.
      c. Flange joints shall have standard 125 pound drilling.
      d. Band couplings shall not be considered a fixed joint.
   3. Droplegs:
      a. Provide at least 1 independent dropleg for each Zone as indicated on the Drawings.
      b. Provide Schedule 10 seamless Type 304L stainless steel dropleg pipes as specified in Section 15286 - Stainless Steel Pipe, and as indicated on the Drawings.
      c. Provide a 125-pound drilled flange connection at top of the dropleg.
      d. Extend dropleg to approximately 2 feet above manifold.

e. Provide plain end at lower end of the dropleg.
f. Connect dropleg to manifold with a Type 304 stainless steel flexible transition coupling.
g. Install piping plumb with walls and make up all changes in direction with standard pipefittings.

4. Manifolds:
   a. Provide Schedule 80 PVC manifolds with PVC compound cell classification as specified in Materials.
   b. Shop fabricate the manifolds in sections of 20 feet or less to conform with the accepted layout for the equipment supplied.
   c. Maintain a constant bottom elevation of the manifolds throughout the basin.
   d. Provide removable blind flanges or threaded end caps at the ends of all manifolds to allow purging of debris prior to system start-up.
5. Laterals:
   a. Lateral grid piping includes all submerged piping other than the droplegs, manifolds, and the moisture blow-off piping.
   b. Provide lateral grid piping in accordance with ASTM D2241 and sized for SDR 33.5 or thicker. All fittings shall have pressure ratings not less than the attached piping and shall in accordance with ASTM D3034 with a maximum SDR of 33.5.
   c. Shop fabricate the laterals in sections of 20 feet or less.
   d. Field join lateral sections using flanged joints with gaskets. Connections shall permit rotation of each section independent of adjacent sections.

C. Piping supports:
1. General:
   a. Provide supports of both guide and fixed type to allow for expansion of the system:
      1) Submit proposed pipe support layout and design for Engineer's review and acceptance prior to manufacture.
      2) Include all details outlined in Submittals.
   b. For the welded parts of the pipe supports, use Type 304L stainless steel in accordance with ASTM A240 with a No. 2D finish and a maximum carbon content of 0.030 percent.
   c. For the non-welded parts of the supports, such as concrete anchors, nuts, and washers, use Type 304 stainless steel in accordance with ASTM A240.
   d. Fabricate the supports using flat stock of at least 18-gauge by 1-1/2 inches and rods of at least 5/16-inch diameter.
   e. Supports shall be adjustable to allow movement of pipe and to compensate for a minimum variation in tank floor elevation of approximately 3 inches:
      1) All adjusting devices shall lock in place after piping has been installed and leveled.
   f. Attach supports to the tank floor using expansion type concrete anchors designed for embedment in 3,000 pounds per square inch concrete:
      1) Size anchors for pullout strength against calculated buoyant forces, based on a design safety factor of 5 or more.
   g. Design supports to allow for complete removal from the tank (less anchors) to facilitate cleaning and maintenance of tank bottom.

2. Manifold supports:
    a. Provide a minimum of 2 supports with a maximum spacing between supports of 8 feet.
    b. Design support system to resist thrust generated by expansion or contraction of pipe.
    c. Design the manifold supports to include a manifold hold-down, guide straps, anchor bolts, and supporting structure. Use minimum 2-inch wide guide straps. Provide supports with a mechanism allowing for within 1.5 inches adjustment for alignment of the manifold in the field.
3. Lateral supports:
    a. Provide supports with a mechanism allowing for within 1.5 inches vertical adjustment for alignment of the laterals in the field.
    b. Adjusting and aligning mechanism shall be infinitely adjustable within its limits to allow precise leveling of the laterals and diffuser assemblies to within 1/4 inch of a common horizontal plane without removing the lateral from the support.

D. Diffuser assembly:
1. General:
    a. With each complete air diffuser assembly, include a membrane diffuser element with matching baseplate, diffuser holder, threaded retainer ring, and an airflow control orifice.
    b. Diffusers elements utilizing ceramic or plastic type diffusion media elements or ones that require a center bolt to limit membrane deflection will not be acceptable.
    c. With each blank diffuser assembly, include a baseplate, threaded retainer ring, and an airflow control orifice.
    d. Design, manufacture, and install the entire system in such a manner that all the diffuser elements are within 1/4 inch of a common horizontal plane.
    e. Air distribution shall be uniform throughout the entire system as specified in performance requirements.
2. Membrane diffuser element:
    a. Type: Membrane disk.
    b. Size: 9-inch diameter.
    c. Material: Provide membrane material specifications as outlined in Materials.
    d. Manufacture the membrane as a seamless, single extrusion or molding without defects or repairs and integral sealing ring on periphery of diffuser element:
        1) Surface of the membrane shall be smooth to prevent attachment of biological growth.
    e. Design the membrane diffuser element to collapse and seal on the supporting baseplate to prevent backflow of mixed liquor into the air piping when aeration air is turned off.
    f. Design for the membranes to be replaceable in the field without needing to remove the diffuser assembly from the basin.
3. Baseplate:
    a. Provide PVC baseplate to completely support membrane diffuser element and prevent reverse flexing.
    b. Baseplate shall include air release port centered in the baseplate.

4. Diffuser holder:
    a. Each diffuser shall incorporate a diffuser holder integrally bonded to the piping system and designed to provide complete peripheral edge support for the membrane element.
    b. Diffuser holders attached via mechanical fasteners, such as rivets, shall not be acceptable.
    c. Solvent weld each diffuser holder to the lateral grid piping in the factory such that the flat surface of all diffuser holders lie in the same plane along the length of the lateral grid piping; warping of this planar surface shall not be permitted:
        1) Diffuser elements shall be located directly above the centerline of the lateral pipes.
        2) Elements that are offset or cantilevered shall not be allowed.
    d. Secure the membrane diffuser element to the diffuser holder using a PVC retainer ring screwed on to the diffuser holder with the outer edge of the membrane diffuser element located in the groove provided:
        1) Use a hold-down ring of sufficient length to allow engaging a minimum of 1 full thread before compression of the membrane outer edge begins.
        2) Strictly adhere to manufacturer's recommendations during installation and tightening of the hold-down ring.
        3) Take precautions to avoid overtightening of the hold-down rings.
5. Airflow control orifice:
    a. Each diffuser assembly shall incorporate a flow control orifice sized to provide equal air distribution throughout the grid. Should a diffuser element break, the flow control orifice shall be capable of maintaining uniform distribution of air throughout the system.
    b. Design the airflow control orifice to be capable of being completely sealed.
    c. Factory drill the flow control orifices under controlled shop conditions prior to shipment of the diffuser assemblies to the job site.
    d. No field drilling of flow control orifices is allowed.
    e. Provide removable orifice plugs for specified blank air diffuser assemblies:
        1) Design plugs to be capable of preventing any airflow leakage throughout the specified range of flows.
        2) Design plugs to allow removal using pliers.

E. Moisture blow-off system:
1. Provide a minimum of 1 moisture blow-off system per grid including all required pipe, fittings, valves, and accessories.
2. Design the moisture blow-off system to be capable of effectively removing any liquid that has entered the piping system.
    a. Include a sump in the piping at the location of the purge pipe to allow the purge pipe to extend below the invert of the manifold and completely remove moisture from the manifold.
    b. This fitting shall be a cross or a tee with a factory-solvent welded cap installed on the downward facing branch.
    c. Locate the sump at the side of the grid opposite the dropleg to allow accumulated moisture to migrate with the airflow towards the sump.

3. Moisture blow-off system shall consist of a medium or coarse bubble diffuser, Flexcap™ or equal, located at the bottom of each manifold to allow moisture to be continuously purged from the system. Diffuser shall be equipped with a diaphragm check valve feature to prevent backflow of water into the aeration system in the event aeration stops.

F. Fasteners and hardware:
   1. Provide all bolts, nuts, and washers of Type 304 stainless steel.

2.04 DIFFUSER PHYSICAL PERFORMANCE TESTING:

A. General:
   1. The fine bubble aeration equipment shall be shop tested as specified.
      a. No corrections shall be made to the measured values of any parameter for possible errors due to instrument calibration, method of measurements, data observation, reduction of data, or measurement accuracy.
   2. Perform oven age testing on the membranes as part of the quality control testing.
      a. Results of the Accelerated Aging Test shall meet the criteria specified in Materials.
   3. Sample and test the membrane diffuser elements for air distribution uniformity, dynamic wet pressure (DWP), and dimensional tolerance as specified.
   4. Submit a testing and sampling plan designed to insure consistently good quality of the diffuser assemblies from each membrane lot.
   5. All tests shall be witnessed by a representative of an independent, certified testing laboratory engaged by the Contractor and approved by the Owner, and may be observed by the Engineer and Owner.
   6. All costs for inspection and testing, exclusive of the costs for the presence of witnesses from the Engineer and Owner, shall be borne by the Contractor.
   7. Notify the Engineer at least 30 days prior to the scheduled testing dates, and confirm the testing schedule at least 3 days prior to the testing date, to allow the Owner to witness the sampling and testing procedure for the diffusers.

B. Uniformity:
   1. Test diffusers in a plan to show that 95 percent of the diffusers within a given lot meet the uniformity requirement. Uniformity is defined as a substantially even distribution of air bubbles across the diffuser surface when the diffuser is operating submerged in water.
   2. The uniformity testing apparatus shall consist of a container for testing the elements individually and calibrated instruments for the measurement of all variables.
      a. Provide a container or test box with suitable clamping devices for holding the membrane element in position and completely sealing the element against the passage of air except through the exposed face.
         1) The holding device shall be such that the air is distributed uniformly across the surface of the element.
      b. Use a nonpulsating air supply.
      c. If necessary, use a reservoir to dampen pulsation in the blower discharge piping.

3. Membrane elements to be tested for uniformity:
    a. Saturate with tap water, clamped in position, and submerged in a depth of 2 inches of tap water.
    b. Air shall then be diffused through the element at a rate of 12 standard cubic feet per minute per square foot of effective surface area for 1 minute.
    c. The airflow rate shall then be reduced to 1.0 standard cubic feet per minute per square foot of effective surface area, and the uniformity of diffusion observed and recorded as satisfactory or rejected.
4. All diffusers not satisfying the uniformity requirement shall be rejected.
5. If the uniformity tests do not show substantial uniformity, additional tests shall be made as necessary to assure that elements with uniform permeability are being obtained.
    a. The cost of any additional tests shall be borne by the Contractor.

C. Dynamic wet pressure (DWP):
1. Test diffusers in a plan to show that 95 percent of the diffusers within a given lot fall within 10 percent of the average DWP. DWP is defined as the pressure to operate at the specified conditions minus diffuser submergence and flow control losses.
2. Test diffusers in a room maintained at 70 degrees Fahrenheit within 5 degrees Fahrenheit and 10 to 50 percent humidity.
3. Use the same apparatus for the DWP test as was used for the uniformity test.
    a. Provide a means of measuring the pressure under the diffuser element.
    b. Submerge the diffusers at least 2 inches of water and operate at an airflow rate of 3.5 scfm per square foot of active diffuser area within 10 percent.
    c. The DWP is the pressure head under the diffuser in inches of water minus the submergence depth in inches.
4. All measured DWP values shall be within 10 percent of the average DWP.
5. All diffusers tested and found outside the acceptable range shall be rejected.
    a. If the lot is found to have a greater variability than specified, all elements of the lot shall be tested and only individual diffusers which meet the variability requirement shall be accepted.
    b. The cost of any additional tests shall be borne by the Contractor.

D. Dimensional tolerances:
1. Test diffuser elements and baseplates for dimensions and trueness of surfaces.
2. All elements with appreciable warping of surfaces shall be rejected. Appreciable warp is defined as irregularities greater than within 0.03 inch.
3. Maintain the following tolerances:
    a. Membrane thickness: 0.08 inch within 0.01 inch.
    b. Membrane disk diameter: 9 inch within 0.10 inch (9-inch diameter disk).
    c. The criteria used to determine the acceptance of the dimensional tolerances shall be the same as for uniformity and DWP.

2.05 AIR MANIFOLD PIPING TESTING:

A. Factory assemble and test the air manifold piping for leaks to a pressure of 10 pounds per square inch, or 1.25 times the maximum allowable pressure, whichever is higher, prior to shipment.

B. Provide written certification in accordance with product data and shop drawings.

2.06 MEMBRANE LONGEVITY TEST REPORTS:

A. Longevity of the proposed membrane diffusers shall have been demonstrated in at least 3 full-scale municipal installations operating continuously for a minimum of 3 years.

B. Test reports, prepared by an independent testing agency, shall confirm membrane longevity through compliance with the following maximum allowed percent (within) change in each membrane property:
   1. Tests conducted in-house by the Supplier shall not be acceptable.

C. Data for a minimum of 3 diffusers from each installation shall be provided.

Property	Maximum Percent Change
Durometer	5 percent
Weight	5 percent
Permanent Set	0.5 percent

2.07 FACTORY STANDARD OXYGEN TRANSFER TEST

A. Perform the test on a mockup of the project installation:
   1. Conduct a factory standard oxygen transfer performance test to demonstrate the capacity of the supplied equipment to meet the specified performance requirements of design requirements.
   2. Tests shall be conducted at the manufacturer's facility by an independent testing firm subject to acceptance by the Engineer:
      a. Tests may be observed by the Engineer and Owner.
      b. All costs for inspection and testing, exclusive of the costs for the presence of witnesses from the Engineer and Owner, shall be borne by the Contractor.
   3. Conduct testing at a location within the continental United States.
   4. Perform all testing in accordance with the referenced ASCE 2-91:
      a. The test procedure shall include analysis of the tap water in the test tank for total dissolved solids by a certified testing laboratory, both before and after the test.
   5. Run all tests using diffusers of identical size and type to those supplied for the project.
   6. Conduct at least 3 test runs at the airflow rate specified in design requirements, to establish an average clean water SOTE for the specified testing zone.

7. Conduct testing in a tank having a surface area larger than 200 square feet to eliminate the potential of wall effects:
    a. Further, conduct testing at submergence depths and diffuser densities equivalent to the actual project configuration of the specified testing zone.
8. The diffuser layout in the test tank shall be subject to the approval of the Engineer:
    a. As far as practicable, the diffuser layout in the test tank shall represent the actual full-scale layout, as shown in the diffuser grid shop drawings approved by the Engineer.
    b. The test tank diffuser layout shall include representative access-ways, header groupings, and diffuser spacing.
    c. If exact diffuser arrangements cannot be practically achieved during testing, the manufacturer shall perform 2 sets of tests, 1 set at a higher density, and 1 set at a lower density.
    d. Mathematical interpolation calculations shall be provided to demonstrate compliance at the specified floor coverage.
9. The Contractor shall provide shop drawings of the proposed diffuser grid layout for each zone for approval, in accordance with the requirements described in Submittals.
10. The Owner's witness for the diffuser test shall be given access to inspect all test apparatus prior to, during and following the test.
11. The test schedule shall allow for the Owner's witness to inspect the tank prior to filling with tap water, and to witness filling of the tank with tap water.
12. Any retesting, including costs for the presence of witnesses from the Engineer and Owner during retesting, shall be performed and provided for at no additional cost to the Owner.

B. As-built set of diffuser drawings:
1. A maximum of 30 days following the successful completion of the field 7-day test, provide an as-built set of diffuser drawings showing the installed diffuser configuration with all pertinent details including:
    a. Installed number and location of diffusers and droplegs.
    b. Installed configuration of the air distribution piping including valves and fittings, the location of the access ways.
    c. Location of the moisture blow-off piping.

2.08 STORAGE AND PROTECTION

A. Protect the system components at the site and during installation prior to project completion:
1. As a minimum, provide cover, ventilation, and proper stacking to prevent warping of all aeration system piping stored on-site.
2. Covering system shall protect the materials from UV radiation.

2.09 SPARE PARTS

A. Provide the following spare parts:
1. 5 percent of the total diffuser membranes utilized on the project.
2. 1 percent of the total retainer rings and baseplates utilized on the project.
3. 2 spanner wrenches for mounting of diffusers.
4. 1 spare coupling for every type of coupling used.
5. 1 spare moisture blowoff system complete with fittings and fasteners.

PART 3 EXECUTION

3.01 DISASSEMBLY

A. Contractor shall remove and dispose of all existing diffusers in the existing aeration basin trains including aeration zones as well as swing zones.

3.02 INSTALLATION

A. Install all diffusers at an identical elevation within 0.25 inches of a common horizontal plane.

3.03 CLEANING OF AIR PIPING:

A. After installation of the new aeration piping, air from the low-pressure air system shall be discharged at the maximum rate possible for not less than 2 hours:
   1. This procedure shall be repeated.
   2. These operations shall be coordinated with the needs of plant operations through the Engineer.

B. Do not install the diffuser elements until all cleaning operations are complete.

C. Thoroughly clean all new air piping immediately prior to installation.

D. Swab each unassembled piece of grid piping prior to installation.

E. After installation, protect all surfaces from contamination by dust, dirt, construction debris, and moisture, including atmospheric moisture, in a manner satisfactory to the Engineer.

F. Whether or not the pipe upstream has been cleaned, all openings in partially completed work shall be temporarily sealed off except where installation is actively in progress:
   1. Seal off openings where installation is in progress at the end of each day's work, or whenever the work is temporarily stopped for any reason.

G. Suspend work whenever inclement weather is imminent.

H. Thoroughly clean any surfaces which become contaminated prior to acceptance to the satisfaction of the Engineer.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Source Testing.
      b. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      c. Installation: 1 trip, 5 day minimum.
      d. Functional Testing: 2 trips, 2 day minimum each.
   3. Training:

e. Maintenance: 4 hours per session, 2 sessions.
f. Operation: 2 hours per session, 2 sessions.

4. Process Operational Period.
g. As required by Owner or Contractor.

C. Source testing:
1. Test as specified in Section 15958 - Mechanical Equipment Testing.
2. Diffuser physical performance testing.
3. Membrane Fine Bubble Disc Diffuser System:
a. Test witnessing: Witnessed.
b. Factory Standard Oxygen Transfer Testing:
1) Test project installation:
a) A minimum of 60 days prior to the factory tests, a description of the proposed test protocol and test tank layout, for review and approval.
b) Submit shop drawings for the actual proposed diffuser grid layout, so that the test tank layout may be compared with the actual proposed layout.
c) Following approval of test protocol and test tank layout, and a minimum of 30 days prior to the factory tests, a time schedule and location for the tests.
d) A maximum of 30 days after the completion of the factory tests, 5 copies of the test report, signed and stamped by a licensed professional Engineer documenting the results of the Factory Standard Oxygen Transfer Test in full accordance with the referenced ASCE Standard Guidelines for In-Process Oxygen Transfer Testing. The report shall specifically include:
(1) A reference to the latest ASCE Standard Guidelines for In-Process Oxygen Transfer Testing.
(2) Test basin dimensions and modified dimensions.
(3) Diffuser layout and DO probe type and location.
(4) Volume of liquid in the test basin and diffuser submergence.
(5) Type, quantity, and source of chemicals used between all reaeration test runs.
(6) Documentation of calibration of all measurement instruments.
(7) All raw test data placed in an Appendix.
(8) Standard Oxygen Transfer Test procedure.
(9) Data analysis procedure.

D. Functional testing:
1. Aeration Basins:
a. Test witnessing: Witnessed.
b. Conduct Level 2 General Equipment Performance Test.
c. Test for mounting, levelness, air uniformity, and leakage:
1) Notify the Engineer at least 1 week prior to the scheduled testing date, and confirm the testing schedule at least 2 days prior to the testing date, to allow the Engineer or their representatives to witness the field-testing.
2) Replace all items found to be defective.

3) Prior to initiating any field-testing, inspect all piping for proper joints, supports and tie-downs, plugs, and moisture blow-off valves.
4) Provide a field service Engineer to monitor the installation, leveling, and testing of the aeration equipment.
5) Flood the aeration tank with water to the top of the diffusers:
   a) Contractor is responsible for filling and emptying aeration basins with water as required for testing activities.
   b) Contractor shall be responsible for conveying water between the plant effluent water system and the aeration basins.
   c) Provide written notification to the Engineer a minimum of 5 days in advance of any such use of the plant effluent water.
   d) Check the level of the diffusers to insure that they are at the same elevation within 0.25 inch of a common horizontal plane.
   e) The level of the diffusers shall then be checked to insure that they are at the same elevation, within the limits specified:
      (1) After completion of the leveling test, add water to the aeration basins to cover the diffusers with about 3 inches of water.
      (2) Pass air through the diffusers, and check operation of the diffusers.
      (3) Visually inspect the surface of the water above the diffusers to ensure that airflow is uniformly distributed across the tank, as well as uniformly distributed across the surface of each diffuser.
      (4) All diffusers, which in the opinion of the Engineer do not produce a uniformly distributed flow pattern, or do not produce a flow pattern consistent with the majority of the diffusers, shall be replaced.
      (5) Check all air manifold, moisture blow-off, and drop piping above the water surface for leaks with soapsuds after covering the diffusers with water:
         (a) All leaks shall be repaired and testing shall continue until the systems show no visual signs of leakage.

2. 3-day test:
   a. Conduct the 3-day test following successful completion of the field performance tests.
   b. Fill the aeration basins with plant water to normal operating levels.
   c. Operate at normal airflow rates for a minimum of 3 days.
   d. If any diffuser system failures occur during this period, drain the basin(s), make repairs/modifications, and then re-run the 3-day test.
   e. Owner will provide a source of water and electrical energy.
   f. Contractor shall pay for all costs of testing other than the cost of water and energy at their sources.
   g. At the end of the test or retest, leave the basins full of plant water.
3. 7-day test:
   a. Following successful completion of the 3-day test, coordinate with the plant operations personnel in placing the basins in operation.
   b. Provide a minimum of 1 week for the Owner to establish operational conditions in the aeration basins.
   c. Upon notice that the aeration basins have achieved operational conditions, begin the 7-day test.

d. Submit a written procedure for approval prior to beginning the 7-day test.
   1) Correct any deficiencies found during the 7-day test and at the Owner's option, run the 7-day test again at no additional cost.
e. A maximum of 30 days following the successful completion of the field 7-day test, provide as-built drawings of the diffuser installation including all information outlined in Factory Standard Oxygen Transfer Testing Data.

END OF SECTION

[AD2] Addendum No. 2

SECTION 11395A

PRE-ENGINEERED SINGLE-STAGE BIOTRICKLING FILTER ODOR CONTROL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Packaged odor control systems utilizing vertical single-stage biotrickling filters for the purpose of removing hydrogen sulfide odors associated with raw sewage. There is a unit for the headwork's foul air and a separate unit for the lift station's foul air.
   2. Headworks Odor Control Equipment Tagging:
      a. Odor Control System: HW-ODORCONTROL-01.
      b. Foul Air Fan: HW-BLOWER-01.
      c. Recirculation Pump: HW-RECYCLEPUMP-01.
   3. Lift Station Odor Control Equipment Tagging:
      a. Odor Control System: LS-ODORCONTROL-01.
      b. Foul Air Fan: LS-BLOWER-01.
      c. Recirculation Pump: LS-RECYCLEPUMP-01.

B. As specified in DIVISION 01, Section 13390 – Packaged Control Systems, Section 15958 – Mechanical Equipment Testing, Section 17100 – Process Instrumentation and Control Systems, Section 17101 – Specific Control Strategies, and Section 17302 – Flow Measurement – Magnetic Flowmeters.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 – Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 inch Standard.
   2. B73.1 – Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process.
   3. RTP-1 – Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. ASTM International (ASTM):
   1. D 746 – Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   2. D 1998 – Standard Specification for Polyethylene Upright Storage Tanks.
   3. D 3299 – Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

D. National Fire Protection Association (NFPA):
   1. 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.03 DEFINITIONS

A. NEMA Type 4X enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. The Contractor shall be responsible for providing two fully functioning odor control systems.
   1. Headworks Odor Control System shall utilize a biotrickling filter with synthetic media and water recirculation to optimize H_2S removal.
   2. The Odor Control System may be designed to rely on single pass irrigation to meet specified performance. However, components for the recirculation pump system, as specified herein, shall be provided as part of the package to be used during times of process upset.
   3. Plant Influent Lift Station Odor Control System shall utilize a biotrickling filter with synthetic media and water recirculation to optimize H_2S removal.
   4. Equipment for both odor control systems shall be provided by one Manufacturer or responsible system supplier, and shall include but not be limited to the following:
   5. Headworks Odor Control System:
      a. 1 centrifugal fan.
      b. 1 mist eliminators/grease trap.
      c. 1 biotrickling filter unit.
      d. 1 recirculation pump.
      e. 1 nutrient pump to be installed on top of the nutrient reservoir.
      f. 1 FRP nutrient reservoir.
      g. One vendor master control panel.
      h. Plant utility water piping, flow meters, valves, and spray and humidification piping inside the vessel. The acclimation system should be integrated, prewired and pre-piped into the irrigation system. The irrigation control components shall be housed in an NEMA 4X control panel.
      i. Connect maintenance platforms on both filter units allowing access to the spray nozzles.
      j. Associated controls.
      k. Associated FRP ductwork, expansion joints, appurtenances, and accessories.
      l. Consultation and training to the Contractor to assure a properly installed system.
      m. All interconnecting piping external to the biotrickling filter units and water supply vendor control panels shall be provided and installed by the Contractor.
   6. Plant Influent Lift Station Odor Control System:
      a. 1 centrifugal fan.
      b. 1 mist eliminators/grease trap.
      c. 1 biotrickling filter unit.
      d. 1 recirculation pump.
      e. 1 nutrient pump to be installed on top of the nutrient reservoir.
      f. 1 FRP nutrient reservoir.
      g. One vendor master control panel.
      h. Plant utility water piping, flow meters, valves, and spray and humidification piping inside the vessel. The acclimation system should be integrated,

prewired and pre-piped into the irrigation system. The irrigation control components shall be housed in an NEMA 4X control panel.

i. Associated controls.
j. Associated FRP ductwork, expansion joints, appurtenances, and accessories.
k. Consultation and training to the Contractor to assure a properly installed system.
l. All interconnecting piping external to the biotrickling filter units and water supply vendor control panels shall be provided and installed by the Contractor.

B. The odor control system equipment shall be installed as indicated on the Drawings.

C. The odor control systems supplier shall provide media and components suitable for the service conditions listed herein.

D. The odor control systems shall be suitable for installation in an NFPA 820 Class 1 Division 2 Group D hazardous duty location.

E. The odor control systems specified herein shall be a portion of a complete odor treatment train. Many portions of the complete odor treatment train including exhaust fans, ductwork and dampers, and instrumentation and controls are specified elsewhere, and are not included in this specification section.

F. Both the systems specified herein, as well as the components specified in Sections 15814 – Fiberglass Reinforced Plastic Ductwork, shall be supplied by one Manufacturer.

G. Electrical Requirements: See DIVISION 16, Electrical Requirements, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

H. The Contractor shall provide the odor control system as defined in subsection 1.04.A from a single responsible supplier. The SUPPLIER shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features and functions.

I. Odor control units, blowers, air duct, and water piping shall be constructed of materials that are impervious to corrosion and suitable for conditions typically experienced in wastewater treatment plants. Materials shall be resistant to high concentrations of hydrogen sulfide and environments having pH levels below 2; FRP for vessels, fans, and ducting; CPVC for piping as specified herein.

1.05 SUBMITTALS

A. General: Provide Shop Drawings, samples, administrative, quality control, and contract closeout submittals in accordance with the requirements of Section 01300 - Submittals and 01730 – Operation and Maintenance Manuals, submittals and as listed below.

B. Provide Shop Drawings and Samples as follows:
   1. Detailed Structural and Mechanical Layout Drawings showing system fabrication, dimensions, size, and locations of connections to other work.
   2. Complete design calculations for the media support system, structural members, vessel fabrication and anchoring shall be performed, signed, and stamped by a Structural Engineer registered in Texas.
   3. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
   4. Manufacturer's Information on the Biotrickling filter Media, such as:
      a. Pressure drop data through media.
      b. Biofiltration Media Physical Characteristics, including:
         1) Media Volume.
         2) Media Depth.
         3) Residence Time.
      c. Information on expected settling rates of the media per year.
      d. Biotrickling filter pressure drop calculations.
      e. Operating data from previous installations to substantiate media performance claims.
   5. Piping and instrumentation diagrams: Show piping including manual valves, piping material and pressure break points, local indicators, branch connections, bypasses, equipment and instrumentation in Instrumentation Society of America format; schematic to match actual representation of the process flow through the piping, instrumentation measurement devices and equipment.
   6. Control narrative including:
      a. Detailed description of local control operation.
      b. Detailed description of manual control operation through the vendor control panel.
      c. Detailed description of automatic control operation through the PLC interface.
      d. Detailed description of remote control capability through the plant SCADA interface.
      e. Detailed description of all system hardware and software interlocks.
      f. Detailed description of all operator accessible settings and set points.
   7. Certified motor data sheets in accordance with Section 16222 – Low Voltage Motors up to 500 Horsepower.
   8. Wiring diagrams: Show terminal strips and interconnection of devices.
   9. Logic diagrams: Show ladder logic for devices including programmable devices.
   10. Dimensioned layout drawings to scale of system showing vessels, equipment, piping, ducting, valves, switches, control units, and other items.
   11. Where 2 or more Manufacturers are concerned in furnishing equipment for a single control system, the Primary Supplier shall provide a coordinated drawing showing how equipment is to be installed and operate together.
   12. For fiber reinforced thermoset plastic resin construction, provide details on construction including for every layer the thickness, specific resins used, additives used, catalysts used, type of glass mat or fiber used, layup technique and the details and technique for reinforcing openings.
   13. For connections to fiber reinforced thermoset plastic resin or plastic vessel, provide details of the connection type, flanges, backing, bolting, and corrosion protection provided.
   14. External utility requirements.

15. Complete instrumentation, control, logic, and power wiring diagrams in sufficient detail to allow installation of the instrumentation, controls, and electrical components.
16. Coating Systems: Including Manufacturer's descriptive technical catalog literature and Specifications.
17. Field-testing plan for meeting system performance requirements.

C. Provide Quality Control Submittals as follows:
1. Operations and Maintenance Data.
2. Manufacturer's Certification of Compliance that the factory system is identical to the requirements specified herein.
3. Manufacturer's Certificate of Proper Installation.
4. Manufacturer's Training Program.
5. Equipment Testing and Field Startup Report.

D. Product data: Bill of materials and catalog data on all equipment, internals, instrumentation, controllers, relays, switches, and such other accessories as are needed to properly operate the biotrickling filter and the control or metering system.

E. Operations and maintenance manuals:
1. Manuals for items comprising the biotrickling filter systems as specified in Section 01730 – Operation and Maintenance Manuals.
2. Components: Provide information for components; detail as specified in this Section and in Section 15050 – Common Work Results for Mechanical Equipment.

F. Control System Software Record Documents:
1. Include complete documentation of all the software programs provided for the control system, including:
a. Listings of all application software on both hard copy and USB.
b. Database, both hard copy and USB.
c. Communication protocols.
d. All documentation necessary to maintain, troubleshoot, modify, or update the software system.

G. Closeout submittals:
1. Provide warranty certificates.

1.06 QUALITY ASSURANCE AND CONSIDERATION OF ALTERNATIVES

A. Manufacturer Qualifications: The biotrickling filter system Manufacturer/supplier shall be one recognized and established in the design, production, and manufacturing of Biological odor control systems. The biotrickling filter system Manufacturer/supplier shall have at least 10 years' experience in design and fabrication of similar systems as demonstrated by a list of at least 5 successful installations of comparable size for the Headworks (approximately 3,000 cfm) as well as the Lift Station Odor Control System (approximately 1,500 cfm) at municipal wastewater treatment plants in the United States, which have been in operation for at least 2 years, with at least a 99 percent hydrogen sulfide removal efficiency. References must include valid names and phone contact numbers that can be verified.
   1. Provide 3 references for units in the United States, include Owner name, current phone number, and summary design criteria (air cubic feet per minute, inlet and outlet odor concentrations).
   2. Testing firm: Provide odor system testing firm qualifications.

B. The biotrickling filter system supplier must be able to provide the Owner with training and monitoring support service during the first 2 years of operation.

C. System Responsibility:
   1. Primary Supplier: A single vendor:
      a. Responsible for two separate odor control systems which for both include a biotrickling filter vessel, vessel internals, packing, liquid distribution, an irrigation pump, demisting section, vendor control panels, instrumentation, a fan, chemical metering pumps, and other components of the package system.
      b. Responsible for furnishing the system as specified herein, for delivery to site, assistance with installation, start-up, testing and for warranty of the system design and performance.
   2. All components of the Odor Control Systems (Section 11395A), Fiberglass Reinforced Ductwork (Section 15814 – Fiberglass Reinforced Plastic Ductwork), and Ductwork Accessories (Section 15820 – Ductwork Accessories), shall be provided by a single odor control system supplier to achieve single source warranty and process performance responsibility.
   3. FRP system manufacturer shall have maintained a facility for at least 10 years that Manufacturers the fiberglass vessel and components.

D. Site Representative:
   1. Primary Supplier Required to have one or more qualified representatives at the site to advise the Contractor in the proper unloading at the site, setting the skids at the site, duct installation, other installation work, connections to other parts of the Work, initial check out, device calibration, pre-start-up testing, control parameter settings, performance testing and correction of problems occurring during this period.

E. Consideration of Alternatives:
   1. Alternative system Manufacturers not listed in Article 2.01 Paragraph A that meet all technical qualifications and specifications will be considered during the Bid Period. To proceed with consideration of alternatives during the Bid Period, Contractor shall provide all information listed below and all information required to prove conformance with the following:
      a. Manufacturer shall meet the qualification requirements of Article 1.06, Paragraph A. Manufacturer shall provide a signed affidavit stating conformance with these requirements.
      b. Manufacturer must provide references for the installations meeting the design and performance criteria of this Section 11395A as follows:
         1) Reference information shall include treatment plant name and location, contact name for personnel at treatment plant, contact telephone number, date of installation, date of start-up, model number of unit installed, and number of units installed.
         2) Owner reserves the right to contact any installation that owns equipment manufactured by the proposed alternative Manufacturer to evaluate equipment performance and Manufacturer's services.
      c. Contractor shall provide all information required to prove conformance with all technical and material requirements of this Section, including a written step-by-step control description from the Manufacturer demonstrating understanding of the required operational controls for the odor control system.
      d. Contractor shall provide layout plans showing the equipment layout with all necessary building, structural, piping, ducting, electrical, control, and other modifications. Contractor shall be responsible for all modifications required to provide fully functioning odor control systems that meet required performance criteria. If equipment is accepted, all modifications required to provide a fully functioning odor control system shall be at no additional cost to the Owner.
      e. The submittal must include a complete discussion of the current project as well as descriptions of qualifying projects. The submittal shall also include history and financials of the company as well as the list of staff and their qualifications.
   2. All information specified in this Article 1.06, Paragraph E.1 shall be provided a minimum of 5 weeks prior to the end of Bid Period to allow for evaluation of equipment and associated odor control system and facility modifications.
   3. Owner reserves the right to reject alternative equipment upon:
      a. Failure of timely submission of all information specified in Article 1.06, Paragraph E.1 during the Bid Period.
      b. Failure to prove conformance with specifications.
      c. Poor references for equipment performance and/or Manufacturer's services.
      d. Failure to demonstrate to the satisfaction of the Owner that the quality is equal to equipment made by the Manufacturers named in this Section.
      e. Incomplete scope of materials or capacity.
   4. Alternative equipment proposed by the Contractor after the Bid Period shall not be considered.

1.07 WARRANTY

A. Warrant specified performance and all system components for 2 years from the date of acceptance. Date of acceptance shall start on the day the system has passed the 7-day continuous field test for reduction of hydrogen sulfide under specified average and peak loading conditions. See Article 3.04 for these test conditions.

B. Warrant the biotrickling filter vessel for 10 years from acceptance for defects in material and resistance to the hydrogen sulfide and ambient environment specified.

C. Performance Guarantee: The biotrickling filter Manufacturer shall guarantee the performance of the system for 2 years from the date of acceptance of the system. If within the 2-year guarantee period, the system fails to meet the performance H_2S concentration as specified below, the biotrickling filter Manufacturer shall make all corrective actions necessary to maintain the system performance at no additional cost to the Owner. The corrective actions shall include replacing media and /or parts of the biotrickling filter, making adjustments to the operating components of the system, and for replacing the entire system and all associated components.

D. Warrant that the biotrickling filter media will not compact, degrade, or decompose for a period of 10 years from the date of Substantial Completion, provided that the system is operated in accordance with the Manufacturer's printed Operation and Maintenance Manuals.

1.08 ODOR SOURCE TESTING AND ANALYSIS

A. Conduct source testing for headworks exhaust as well as influent lift station exhaust; testing to be by an independent third party qualified for source testing sampling and analysis; submit qualifications of proposed testing firm. Coordinate schedule for testing with Owner.

B. Conduct continuous H_2S monitoring on each odor source and vessel for a minimum of 7 days using a continuous gas analyzer.
   1. Equip analyzer with a strip type chart recorder or equivalent means to record data.

C. Report the source testing results for review, and confirmation of treatment system performance requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, components, and accessories specified in this Section shall be products of one of the following, or engineered approved equal:
   1. Daniel Company.
   2. ECS Environmental Solutions
   3. BioAir Solutions.

B. Manufacturers/suppliers who wish to be considered equal per 2.01.A.2 must show compliance with subsection 1.06.

2.02 DESIGN CRITERIA

Headworks Odor Control System	
Peak Inlet H_2S (ppm)	200
Average Inlet H_2S (ppm)	25
Average H_2S Removal Efficiency	Greater than 99 percent; or less than or equal to 0.5 ppmv, whichever is higher
Total System Airflow Rate (cfm)	3,000
Individual Unit Capacity (cfm)	3,000
Number of Units	1
Minimum Empty Bed Residence Time (sec.)	15
Media Height (ft)	7.14
Maximum Pressure Drop Across Unit (in. w.c.) per Unit	4
Maximum Temperature (degrees Fahrenheit)	130
Maximum vessel dimensions, L x W x H (each unit, ft)	15 x 7 x 13

Lift Station Odor Control System	
Peak Inlet H_2S (ppm)	500
Average Inlet H_2S (ppm)	25
Average H_2S Removal Efficiency	Greater than 99 percent; or less than or equal to 0.5 ppmv, whichever is higher
Total System Airflow Rate (cfm)	1,500
Individual Unit Capacity (cfm)	1,500
Number of Units	1
Minimum Empty Bed Residence Time (sec.)	15
Media Height (ft)	6
Maximum Pressure Drop Across Unit (in. w.c.) per Unit	4
Maximum Temperature (degrees Fahrenheit)	130
Maximum vessel dimensions (each unit)	9 foot diameter, 14 feet high

A. Piping and ducting:
   1. Provide flanged connections for external connections to the system; provide flexible couplings at the connection points.
   2. Support independently from equipment to avoid loads to equipment nozzles.
   3. Isolate loads due to thermal expansion of piping from equipment.
   4. Piping and fittings: Schedule 80 CPVC minimum strength.

B. Electrical and instrumentation:
   1. Area classification: Class 1, Division 2, Group D if within 3 feet of the fan; within any fan enclosure; or within 3 feet of fittings, flanges or other openings in accordance with NFPA 820.
   2. Terminations: Terminate wiring for external control and power connections in junction boxes.
   3. Control system: Fully automatic irrigation and with an integrated acclimation system which incorporates a nutrient feed to maintain microbial population as necessary to maintain removal performance; other requirements as specified elsewhere in this Section.
   4. Meet the component requirements for electrical systems and control systems as specified in the Contract Documents.

2.03 PROCESS DESCRIPTION

A. Both odor control process utilizes two layers, consisting of an inorganic porous substrate, to support a thin film sulfur oxidizing bacteria for the removal of H_2S. The systems are up-flow vapor-phase design providing integrated sections:
   1. Nutrient/humidification.
   2. Air distribution.
   3. Inorganic media.
   4. Irrigation/acclimation system.

2.04 SINGLE-STAGE BIOTRICKLING FILTER SYSTEM

A. Material of Construction:
   1. The FRP vessel will be manufactured utilizing the helical filament winding method of fabrication in accordance with ASTM D3299, ASTM D4097, and ASME/RTP-1. This method will be used with a winding angle measured about the shell axis of 65-75 degrees. All hand lay-up laminates for nozzles, fittings, and manways will be in accordance with NBS PS 15-69 standards. Any material of construction other than FRP with premium grade vinyl ester resin will not be allowed. Fiberglass reinforced plastic (FRP) fabrication must meet the requirements of this specification and Specification Section 06608 – Fiberglass Reinforced Plastic whichever is stricter.
   2. Resin used in the system liner shall be a premium fire retardant vinyl ester type such as Hetron 922FR by Ashland Chemicals, Derakane by Dow Chemical, or approved equal. The resin shall be reinforced with an inner veil of a suitable synthetic organic fiber such as Nexus 111-00010.
   3. Reinforcement: Glass fiber reinforcement used shall be commercial grade corrosion resistance borosilicate glass.
   4. All glass fiber reinforcement shall be Type C, chemical grade, Type E electrical grade.
   5. Surfacing veil shall be 10 mil Nexus 111-00010 or equal.
   6. Mat shall be Type "E" (electrical grade) glass, 1 1/2 oz. per sq. ft with a nominal fiber length of 1.25 $\pm$ 0.25 inches, with a silane finish and styrene soluble binder.
   7. Continuous glass roving, used in chopper gun spray-up applications shall be type "E" grade with chrome or silane coupling agent.
   8. Alternate layers of mat and woven roving used for reinforcement

9. Miscellaneous:
    a. Stainless Steel: Unless otherwise specified, all fasteners, and metal attachments, such as anchors, brackets etc shall be ANSI 316SS.
    b. Gaskets: Unless otherwise specified, all gaskets shall be EPDM.

B. Fabrication:
1. General: Fabrication shall be in accordance with Section 06608 – Fiberglass Reinforced Plastic and NBS PS 15-69, ASTM D 3299 and ASTM D-4097. The more stringent requirements shall apply. All non-molded surfaces shall be coated with resin incorporating paraffin to facilitate a full cure of the surface. All cut edges, bolt holes, secondary bonds shall be sealed with a resin coat prior to the final paraffinated resin coat. All voids to be filled with a resin paste.
2. Corrosion Liner: The inner surface of all laminates shall be resin rich and reinforced with one Nexus 111-00010 with a minimum thickness of 10 mils. The interior corrosion layer shall consist of 2 layers of 1 1/2 oz. per sq. ft. chopped strand mat. If the application is by chopper gun spray up the glass fiber shall be 1/2 to 2 in length. The total corrosion liner thickness shall be a minimum of 100 mils and have a resin to glass ratio of 80/20. All edges of reinforcement to be lapped a minimum of one inch.
3. Structural Laminate: Structural laminates shall consist of alternating layers of 1-1/2 oz per sq. ft mat or chopped glass and 24 oz per sq. yard woven roving applied to reach a designed thickness. Actual laminate sequences shall be per the laminate tables shown on fabrication drawings. The exterior surface shall be relatively smooth and shall have no glass fibers exposed. The exterior shall be surface coated with gel coat containing ultra violet light inhibitors.

C. Media Support System: FRP.
1. Media support plates and grating shall be rated for a minimum of 250 lbs/ft^2, and mid-span supports shall be suitable to support the weight of the media and entrained liquid solution.

D. System Piping per Section 15259:
1. Exterior: Schedule 80 CPVC.
2. Interior: Schedule 80 CPVC.

E. System Ductwork and accessories per Sections 15814 – Fiberglass Reinforced Plastic Ductwork and 15820 – Ductwork Accessories – Ductwork Accessories.

F. The vessel shall be equipped with the accessories as listed below:
1. All necessary access doors, nozzles and other attachments. Vessel connection flanges shall be compatible with connecting piping and ductwork.
2. At least one side entry manway shall be provided every 5 feet for each lift and spray nozzle assembly with bolted flanged covers and rated for 10-psi minimum. Bolted manways shall be provided with 1/8-inch thick full-face neoprene gaskets with 316 stainless steel bolts. Provide manways as needed for media and nozzle inspection, access to internals, and media replacement for the biotrickling filter and as shown on the plans
3. All bolts and fasteners shall be Type 316 stainless steel.
4. All gaskets shall be EPDM.

G. Spray Irrigation/Acclimation System:
   1. The irrigation system shall consist of a uniform spray non-clogging type nozzle assembly above the top media layer.
   2. Nutrient Pump and FRP nutrient reservoir rated for 30 day capacity:
      a. Rated head as required to pump liquid from the bottom nutrient solution tank to the spray nozzles.
      b. The nutrient pump motor shall be sized and selected by the odor control supplier.
      c. Motor shall meet the requirements of Section 16222 – Low Voltage Motors up to 500 Horsepower.

H. Pipe Supports:
   1. For supports not shown on Drawings, Contractor is responsible for installation of all pipe supports in coordination with odor control system supplier.

I. Exhaust Sample:
   1. Provide pipe and fittings to connect ¼-inch exhaust sample PE tubing inside ¾-inch CPVC pipeline to the exhaust stack. The ¾-inch port shall have an internal air trap to ensure that when open, the sample connection will capture free-flowing air. The sample connection and piping described above shall also be provided for the inlet side of the system. The manufacturer shall coordinate the inlet sample location with the Engineer.
   2. Test ports shall be provided per manufacturer's recommendation and included as part of the system.

2.05 MEDIA

A. The media shall be random-dump type or engineered structured plastic type, without any carbon, lava rock or expanded clay components.

2.06 ACCESSORIES

A. Air inlets, air outlets, spray headers, media support, drains, and all connections whether shown on the Drawings or not shall be provided by the Manufacturer. Tie down lugs shall be integrally molded into the walls of the vessels. All external bolts shall be 316SS and designed for the specified loads. Interior fasteners shall be of corrosion resistant materials such as CPVC or FRP.

B. FRP grease traps are required for the odor control system immediately before the centrifugal fan moving air into the biotrickling filter. Grease traps shall be designed by the odor control Manufacturer and shall not exceed 1.2 inches w.c. pressure drop at the fan design airflow rates. Provide differential pressure indicating switch with 316 SS tubing across the grease filter and wired to the control panel as specified and shown on the plans.

C. Neoprene Pad: A 1/4-inch thick neoprene rubber sheet must be placed underneath the biotrickling filter vessel.

D. One water control panel shall be provided for each biotrickling filter unit. Each water control cabinet shall be FRP NEMA 4X construction. The cabinet shall be mounted on two stainless steel Unistrut columns anchored to the concrete slab. The cabinet shall contain the following components:
   1. Make-up water flow reducing valve.

2. Make-up water solenoid valve.
3. Make-up water rotameter.
4. Recirculation line flow meter.
5. Recirculation line flow switch.
6. Recirculation line flow control valve.
7. Recirculation line sample port with valve.
8. pH probe.

E. Solenoid valves and rotameters shall be provided for control of water application rates. These components shall be sized and selected by the odor control supplier. Provide CPVC diaphragm valves, 316 SS pressure gauges, 316 SS differential pressure gauge across media section, 316 SS solenoid valves, and CPVC pressure regulating valves by reputable Manufacturers.
   1. Pressure gauges shall meet all requirements of Section 17404 – Pressure/Vacuum Measurement – Gauges and shall be provided for make-up water and recirculation lines.

F. Water Flow Control: The direct-reading rotameter shall be a variable area type with a Teflon® float, EPR O-rings, and CPVC fittings. The rotameter shall be of the same size as the pipe in which it is installed. The rotameter shall have a direct reading scale.

G. Nutrient Addition: Provide a nutrient storage tank and metering system with each module. Nutrients supplied as a coating to the support media shall not be allowed. The injector/eductor systems and piping shall be sized by system supplier. The initial supply of nutrient until after a successful mechanical test and successful performance test results shall be supplied by the odor control supplier.

H. Nutrient reservoir: Provide nutrient storage tank (30-day storage capacity, or 55 gallons, whichever is greater).

2.07 CENTRIFUGAL FANS

A. As specified in Section 15830 – Fans. Tags provided in Summary. The fans shall be furnished as part of the odor control system.

2.08 PLANT WATER REQUIREMENTS

A. The Contractor shall provide a NPT plant water line to each odor control vessel, as indicated on the Drawings. Plant water shall be provided at a regulated 70 psig ± 5 psi. The Contractor shall supply all utility water piping as indicated on the Drawings. All insulation and heat tracing shall be integrated and supplied by the Contractor.

2.09 INSTRUMENTATION AND CONTROLS

A. General Strategy:
   1. Lift Station Reference Drawings:
      a. 15N01, 15N02, 15N03.
      b. 15814 – Fiberglass Reinforced Plastic Ductwork – FRP Duct and Accessories for Odor Control.
   2. Headworks Reference Drawings:
      a. 25N01.

b. 15814 – Fiberglass Reinforced Plastic Ductwork – FRP Duct and Accessories for Odor Control.

3. Abstract:
   a. The influent pump station odor control fan draws foul air from the influent lift station headspace.
   b. The headworks odor control fan draws foul air from headspace in the headworks, channels, screenings dumpster room and headworks equipment including grit removal system, as shown on the Drawing 20H04.
   c. The biotrickling filter shall be used to remove odorous compounds from air drawn from the headspace.
   d. The filter unit will contain an inorganic porous substrate to support a thin film sulfur oxidizing bacteria for the removal of H2S.
   e. NPW is uniformly distributed to the media to keep it moist and provide nutrients to the bacteria. Irrigation is provided by the plant NPW and controlled by the water control panel. Manufacturers may use a single pass system irrigation system or rely on a pump to recirculate flow. Irrigation controls shall be designed by the manufacturer to provide a fully functioning system, able to be adjusted by operators through the SCADA system. Nutrient feed is pumped only during startup of the biofilter and operates for an adjustable period of time, and can be ceased once the population is established.

B. pH metering system:
   1. Provide a pH metering and control system to measure and control the pH of the used process water and to control the make-up water.
   2. Install the pH system controller on the scrubber system skid; install controller/transmitter in the control panel.
   3. The pH analyzer shall be on-line serviceable including probe removal for servicing or cleaning.
   4. The pH analyzer and control units: Manufacturers: The following or equal:
      a. GLI/Hach, Model 672.
   5. Provide 1 spare pH probe packaged for long-term storage.

C. Vendor Control Panel:
   1. The biotrickling filter Manufacturer/supplier shall provide one PLC-based main Vendor Control Panel (VCP) for each odor control system to have the logic and controls for the following components or capabilities to handle all modules. This control panel will be mounted outdoors near the odor control unit. Refer to Section 13390 – Packaged Control Systems for system requirements.
   2. Master VCP shall include the following items:
      a. The VCP shall be provided with a single 480 volt, 50 amp, 3-phase 60 hertz power supply. Distribute power to all other loads in the odor control system from the VCP.
      b. VCP shall contain all timers, circuit breakers, interlocks and input and output signals and control power to fully operate the irrigation solenoid valves and nutrient pumps, and interconnect with the utility water supply panel.
      c. VCP located at the headworks odor control system shall be installed with a sun shade.

d. Components:
    1) Provide all components in accordance with Section 13390 – Packaged Control Systems and Division 17.
    2) VCP shall have provisions for communication with the plant SCADA as shown on Drawings.
    3) VCP shall contain UPS Unit.
    4) Enclosure:
        a) NEMA 4X.
        b) The control panel shall be UL approved and labeled.
    5) Main circuit breaker:
        a) As specified in Section 16600 – Disconnect Switches and Enclosed Circuit Breakers.
        b) Flange-mounted operator:
            (1) Pad-lockable in the off position.
        c) Disconnects all power to the panel.
        d) Interlock with the panel door.
            (1) Defeat mechanism.
e. Fault Current Sizing:
    1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
    2) Normal system connections and those that result in maximum fault conditions.
    3) Tabulation of circuit breaker, fuse, and other protective device ratings compared to maximum calculated short-circuit duties.
    4) Fault current calculations for the cases run including a definition of terms and guide for interpretation of computer software printouts.
f. Motor starter (Section 16444 – Combination Motor Starters) with motor circuit protector circuit breaker for each motor starter including but not limited to the following:
    1) Each Foul Air Odor Control Fan.
        a) Provide current monitoring for each motor.
    2) Each Recirculation Pump.
    3) Each Nutrient Pump.
g. Control power transformer:
    1) Primary voltage: 460 VAC, 3 phase, 60 hertz.
    2) Secondary voltages:
        a) Control and status points to the facility SCADA system: 120 volt.
        b) Additional voltages as required by the application.
    3) Sized for all panel components plus 10 percent spare capacity.
    4) Primary and secondary fuses.
h. Control components:
    1) Terminal strips:
        a) Provide terminal strips for landing all external wiring.
    2) Relays, timers, and other components as required providing the specified functionality and remote monitoring connections.
i. Control system programming:
    1) Programming – The vendor shall be responsible for preparing, writing, and testing all logic associated with the VCP.

2) The vendor shall be responsible for participating in a programming conference call with the PROGRAMMER prior to beginning the program process. The purpose of the conference call will be to review the PROGRAMMER requirements for coordination between vendor and PROGRAMMER.

j. Control Devices:
1) Master Vendor Control Panel (VCP):
a) Provide LOCAL-OFF-REMOTE selector switch for the overall system.
b) Provide EMERGENCY STOP mushroom head pushbutton for the entire system.
c) Provide the following indicators:
(1) Overall System Indicators:
(a) Power on indicator.
(b) Run indicator.
(c) Alarm indicator.
(d) Low Level alarm.
(e) Grease Filter/Mist Eliminator high pressure drop.
(2) Foul Air Odor Control Fans:
(a) Run indicator.
(b) Fault indicator.
(3) Nutrient Pumps:
(a) Run indicator.
(b) Fault indicator.
(4) Recirculation Pump:
(a) Run indicator.
(b) Fault indicator.
(5) pH Monitor:
(a) Run indicator.
(b) Fault indicator.
(6) Irrigation Valve.
(a) Open status.
(b) Closed status.
d) Provide the following push buttons:
(1) Foul Air Odor Control Exhaust Fans (one for each):
(a) Provide START and STOP push buttons.
(2) Nutrient Pumps (one for each):
(a) Provide START and STOP push buttons.
(3) Recirculating Pumps (one for each):
(a) Provide START and STOP push buttons.

3. VCP Odor Control Operation:
a. Hardwired Control:
1) With the system HOA switch in HAND:
a) The individual equipment can be controlled by their individual control stations.
2) With the system HOA switch in AUTO:
a) The overall system is controlled by the VCP PLC.
b. Hardwired interlocks
1) The entire system is stopped and prohibited from running if:
a) Any emergency stop pushbutton is activated.

c. VCP PLC Control:
    1) With the system HOA switch in AUTO the overall system is controlled by the VCP PLC:
        a) The starting and stopping of the system is determined by the Plant SCADA system. If SCADA communications is lost the VCP PLC shall run the system continuously as long as the system HOA switch is in AUTO.
        b) When the system is running, the VCP shall operate the overall odor control system:
            (1) The fan operates continuously.
            (2) Irrigation is provided by the plant NPW. Flow of NPW shall be adjustable from the plant SCADA system. Nutrient feed is pumped only during startup of the biofilter and operates for an adjustable period of time, and can be ceased once the population is established.
            (3) Any other necessary operation shall be controlled automatically by the VCP PLC.
d. Software Interlocks:
    1) System shall stop operating if the low level switch is activated.
    2) The irrigation and nutrient feed systems shall operate whenever the foul air fan is operating.
e. Alarms:
    1) Current is monitored for each fan. If the current drops below the setpoint for normal operation, an alarm initiates to notify that the air changes are not being met.

2.10 VALVES, FITTINGS AND CONNECTIONS

A. Material:
    1. Interior installations: Schedule 80 CPVC.
    2. Exterior installations: Schedule 80 CPVC.
    3. Type 316 stainless steel for flange bolts.

B. Valves:
    1. CPVC body diaphragm type with PTFE over EPDM diaphragms.
    2. Provide Hypalon® gaskets and O-rings; gaskets 0.125-inch thickness minimum.
    3. Flanged or union for easy removal or replacement.

2.11 SCRUBBER RECIRCULATION PUMP

A. Each pump shall have a capacity adequate to meet necessary irrigation pressure and flow requirements for a fully functioning system. The pump capacity and head shall be based on the manufacturer's system.

B. The recirculation pump motors shall be a minimum 3.0 Hp Premium Efficiency 460-volt, 3-phase, 60-Hz TEFC motor, having a maximum nominal speed of 1,800 RPM and a service factor of 1.15. Pump shall be seal less, magnetically driven, end-suction centrifugal pump designed to pump low pH fluid. Casing and impellers shall be constructed of polypropylene. Shaft shall be protected from the fluid to prevent corrosion. The drive unit shall be approved for use in a Class I, Division 2, Group D environment. Provide an IEEE 841 compliant motor.

2.12 NUTRIENT PUMP

A. Maximum pressure must not exceed 100 psi.

B. The nutrient pump shall be 115V, 6-Hz, with a maximum output capacity of 1.0 gph.

2.13 ACCESSORIES

A. Lifting Lugs: Equipment weighing over 70 pounds.
   1. Provide a minimum of 4 lifting lugs for biotrickling filter vessel for use in transporting and placing the vessel.

B. Anchor bolts shall be provided by the Contractor in accordance with Section 15050 – Common Work Results for Mechanical Equipment.

C. Biotrickling Filter Level Switches.

2.14 FINISHES

A. Paint the odor control biotrickling filter system piping and equipment as specified in Section 09960 – High-Performance Coatings; Plastic or fiber reinforced thermoset plastic resin vessels, tanks and equipment shall be pigmented in a color selected by the ENGINEER and contain ultraviolet light inhibitors.

2.15 SOURCE QUALITY CONTROL

A. Factory Test: Perform Manufacturer's standard test on equipment. Provide an independent FRP Quality Assurance Inspection report as follows:
   1. Visual inspection to the requirements of ASTM D2563.
   2. Barcol Hardness measurements in accordance with ASTM D2583.
   3. Acetone sensitivity test for all internal secondary bonds.
   4. Glass content by ignition loss on 3 cutouts in accordance with ASTM D2584.

B. Factory Test: Provide certified test reports for the noise level of the fans in conformance with AMCA 300 and ANSI S1.6.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Provide the following:
      a. Inspect equipment upon delivery to job site.
      b. Perform installation of biotrickling filter system equipment including any adjustments, and installation checks for equipment and controls.
      c. Certify alignment and proper control functioning prior to operations.
      d. Conduct start-up of all equipment and perform all required tests including instrument calibration and loop checking and performance testing of components that function as part of the odor control system.
      e. Provide written statement that equipment has been installed properly and is ready for operation by Owner.

3.02 SYSTEM BALANCING AND CHECKING

A. After the odor control system has been installed, checked-out, controls tested, and is and ready for operation, test and balance the entire foul air system as specified for air systems in Section 15954 – HVAC Systems Testing, Adjusting, and Balancing.
   1. Calibrate and adjust all instruments necessary for biotrickling filter system operation.
      a. Adjust controls to achieve the required performance at the rated design condition.
      b. The odor control system supplier shall inspect ductwork, dampers, and expansion joint installation.

3.03 FIELD FINISHING (AND/OR CORROSION PROTECTION)

A. Field touch up in accordance with Section 09960 – High-Performance Coatings.

B. Damage to pigmented gel coat and/or exterior laminate on any FRP component shall be repaired in accordance with equipment fabricator's recommendations. Exposed surfaces will be restored to a uniform texture and color-matched appearance. Color shall be as selected by the Owner.

3.04 FIELD QUALITY CONTROL

A. The Contractor shall provide Field Quality Control Tests in Accordance with Section 01756 – Commissioning, and as follows:
   1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   2. Provide Field Quality Control Tests in accordance with Section 01756 – Commissioning, and as follows:
      a. Conduct airflow test for the biotrickling filter. Flow test equipment shall be certified to provide accuracy to within plus or minus 5 percent of design flow.
      b. Provide pressure differential reading across the vessel. Provide equipment and ports as required for Owner to do monthly operational testing on these locations. Provide a 3/4-inch PVC pipe that extends from the exhaust stack to 4 ft from the base, with standoffs along the side of the vessel. A 1/4-inch pressure equalizer tube shall be inserted within the PVC pipe to convey an air sample from the exhaust stack to the end of the pipe; a valve will be included to close off the lower end of the tubing. A 3/4-inch PVC inlet sample port with ball valve shall be provided at the vessel inlet.
      c. Performance Tests: Coordinate tests with associated instrumentation and control system. Conduct performance test on biotrickling filter system under actual operating conditions of the site as follows:
         1) Test only after supplier approved acclimation period for biotrickling filter. Acclimation is not to exceed 4 weeks. The acclimation of the biotrickling filter media shall be the responsibility of the supplier.
         2) Use portable hydrogen sulfide analyzers approved by ENGINEER. Record inlet and outlet concentrations at least 15-minute intervals, or less (more often).

3) Test the biotrickling filter under normal operating conditions for 7 continuous days.
   a) Verify the required reduction of 99 percent H_2S gas.
4) Provide anemometer or pitot tube instrument on the unit discharge for verification of airflow requirements.
5) A report of the performance test results shall be provided.

3.05 SYSTEM SUPPLIER SERVICES

A. Provide Manufacturer's services at the jobsite for the following time period as follows:
   1. Manufacturer's assistance to the Contractor to include requirements per subsection 3.02.A.1: 2 days and 1 trip.
   2. Manufacturer's Certificate of Proper Installation.
   3. Manufacturer's Training Program: 2 days and 1 trip.
   4. Field Testing: 7 days and 1 trip.

B. Other Services:
   1. Certify alignment and proper functioning prior to operations.
   2. Provided written statement that equipment has been installed properly and is ready for operation by Owner.

3.06 SYSTEM SUPPLIER SEMIANNUAL SERVICE

A. The equipment Manufacturer shall perform semiannual services at the job site during the first year (2 visits in total). The services shall include a site visit every 6 months by a factory technician for equipment inspection, checkout, and adjustment.

B. In addition to the semi-annual services, the following services shall be conducted periodically:
   1. Measure airflow rate of the biotrickling filter system each 6 months.
   2. Re-gasket as necessary.
   3. Repair malfunctioning equipment.

C. The equipment Manufacturer shall submit a written report following each visit for the semiannual services and an annual report.

D. Only services conducted by a factory technician are acceptable. Services conducted by a Manufacturer's representative or agent, are not acceptable.

E. Cost of the service visits shall be included in the bid amount for the odor control system.

END OF SECTION

SECTION 11400

KITCHEN APPLIANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Break Room appliances for Administration Building (90).

1.02 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01300 - Submittals.

B. Product Data: For each appliance type required indicating compliance with requirements, include complete operating and maintenance instructions for each appliance.

C. Appliance Schedule: Submit schedule of appliances, using the same room designations on Drawings.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the residential appliance manufacturer for both installation and maintenance of appliances required for this Project.

B. Source Limitations: Obtain residential appliances through one source from a single manufacturer.

C. Electrical Appliances: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

D. UL and NEMA Compliance: Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.

E. Deliver appliances only after utility rough-in is complete and construction in the spaces to receive appliances is substantially complete and ready for installation.

1.04 WARRANTY

A. Provide one (1) year Manufacturer’s Warranty for Parts and Labor.

PART 2 PRODUCTS

2.01 PRODUCTS

A. Manufacturers: One of the following or approved equal:
   1. General Electric Appliances (GE); www.geappliances.com; 1.800.848.7620
   2. Whirlpool; www.whirlpool.com; 1.866.698.2538

B. Products: Subject to compliance with requirements, provide one of the appliances indicated for each designation in the Schedule at the end of Part 3.
   1. Refrigerator: Side-By-Side with Dispenser:
      a. Basis of design: GE Model GSH25JSXSS:
         1) Finish: Stainless steel
         2) Capacity: 25.3 Cu. Ft.
         3) Dimensions: 35 ¾” X 69 ¾” X 33 9/16”
         4) Water/Ice dispenser in door.
         5) ADA Compliant
         6) Energy Star Qualified.
      b. Whirlpool, equivalent product.
   2. Microwave Oven: Countertop Model
      a. Basis of Design: GE Model PEB2060SMSS
         1) Finish: Stainless Steel
         2) Capacity: 2.0 Cu. Ft.
         3) Dimensions: 24” x 13 25/32” x 19 13/32”
         4) Turntable: glass
         5) Microwave Watts: 1200 W
         6) Power Levels: 10
      b. Whirlpool, equivalent product.

2.02 FINISHES

A. Stainless Steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for plumbing, mechanical, and electrical services, with Installer present, to verify actual locations of services before residential appliance installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Comply with manufacturer's written instructions.

B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

D. Utilities: Refer to Division 15 and 16 for plumbing and electrical requirements.

3.03 ADJUSTING AND CLEANING

A. Test each item of residential appliances to verify proper operation. Make necessary adjustments.

B. Verify that accessories required have been furnished and installed.

C. Remove packing material from residential appliances and leave units in clean condition, ready for operation.

3.04 SCHEDULE

A. Administration Building (90):
   1. Break Room 104– one each of the following:
      a. Refrigerator.
      b. Microwave.

END OF SECTION

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SECTION 11635

AUTOMATIC SAMPLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Automatic samplers and accessories.

1.02 SYSTEM DESCRIPTION

A. Automatic sequential/composite sampler unit, complete with weatherproof insulated fiberglass enclosure, integral programmable controllers, and accessories.

B. Unit shall be designed for use in highly corrosive environments and shall be corrosion resistant.

1.03 SUBMITTALS

A. Submittals shall be as specified in Section 01300 - Submittals.

B. Shop drawings:
   1. Detail drawings or manufacturer's literature to indicate compliance with the specified requirements.
   2. Dimensional drawings.

C. Product Data.

D. Operation and Maintenance Manuals.

E. Warranties.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Teledyne ISCO, Model 5800.
   2. Sigma, equivalent model.
   3. Manning, equivalent model.

2.02 AUTOMATIC SAMPLER

A. Enclosure:
   1. The sampling units shall have a weatherproof-insulated fiberglass enclosure, Plasti-Fab Model 4B shelter assembly, or similar.
   2. Sampler shall be capable of operating in an ambient temperature range of -20 to 120 degrees Fahrenheit.
   3. Provide a heater with electronic thermostat integral with the enclosure.

4. Provide dual exhaust fan assemblies integral to the enclosure.

B. Sampler shall be capable of both sequential and composite sampling.
   1. Sampler shall be configured for composite sampling.

C. The samples shall be automatically composited in a 5-gallon polyethylene container located in a refrigerated compartment maintained between 0 and 4 degrees Celsius.

D. Controls:
   1. The sampler shall operate on a flow proportional basis paced by 4 to 20 mA signal.
   2. The sampler shall have a built-in unit for converting the 4 to 20 mA signal to contact closure input.

E. Sampling intervals: Capable of taking samples at intervals selectable in single increments from 1 to 9,999 flow pulses or timed intervals selectable in 1-minute intervals up to 5,999 minutes between consecutive uniform time intervals or up to 999 minutes for non-uniform time intervals.

F. Sample volume: Selectable in 1.0 milliliter increments from 10 milliliter to 9,990 milliliter.

G. A positive purge shall be provided before and after each sampling to prevent clogging and cross-connection.

H. Suction lift: Sampler shall be capable of drawing a sample up to a vertical height of 25 feet.

I. Pumping rate: Minimum pumping rate shall be 2.0 feet per second through 3/8-inch inside diameter tubing at 15 feet of vertical lift.

J. Power: 120 volt, single-phase, 60 hertz.

2.03 ACCESSORIES

A. Provide 1 set of the following for each sampler furnished:
   1. Spare sample tube: 1.
   2. Spare strainer: 1.
   3. 24 extra 1,000 ml polyethylene bottles with rack.
   4. 1 extra 20-liter polyethylene container.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide, store and install automatic samplers in accordance with the recommendations of the manufacturer.

END OF SECTION

SECTION 12486

FLOOR MATS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Administration Building requirements:
   1. Entry carpet mat.

1.02 SUBMITTALS

A. Section 01300 – Submittals: Requirements for submittals.

B. Product Data: Provide data indicating properties of walk-off surface and component dimensions, including:
   1. Preparation instructions and recommendations.

C. Styles, material descriptions, dimensions of individual components, profiles, features, and finishes.

D. Shop Drawings: Indicate dimensions.

E. Samples:
   1. Selection Samples: Provide samples representing manufacturer’s full range of available colors and patterns.

F. Maintenance Data: Include cleaning instructions, stain removal procedures.

G. Warranty.

1.03 SUSTAINABLE DESIGN SUBMITTALS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design submittals.

B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
   1. Materials Resources Certificates:
      a. Certify recycled material content for recycled content products.
   2. Indoor Air Quality Certificates:
      a. Certify volatile organic compound content for each flooring system.

PART 2 PRODUCTS

2.01 SUSTAINABILITY CHARACTERISTICS

A. Section 01352 – Sustainable Construction Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:
   1. Recycled Content Materials: Furnish materials with maximum available recycled content.

C. Indoor Environmental Quality Characteristics:
   1. Interior Carpet: Maximum volatile organic compound content in accordance with CRI Green Label Plus Testing Program.

2.02 MANUFACTURERS

A. Entrance flooring manufacturers: One of the following or approved equal:
   1. Construction Specialties, Inc., Hughesville and Muncy, PA.
   2. Waterhog Floor Mats, Rockville, MD.
   3. 3M, St. Paul, MN.
   4. Substitutions: Section 00700 – General Conditions.

2.03 MATS

A. Basis of Design: Construction Specialties, Inc. Watershield Square.
   1. Rubber backing.
   2. Polypropylene carpet fibers.

2.04 FABRICATION

A. Fabricate mats in single unit sizes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that floors are ready to receive product.

3.02 PREPARATION

A. Clean and vacuum surfaces thoroughly prior to installation.

3.03 INSTALLATION

A. Install mats completely flat and square with adjacent surfaces.

END OF SECTION

SECTION 12494

ROLLER SHADES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Administration and Maintenance Building requirements for:
   1. Manually operated sunscreen roller shades
   2. Manually operated room-darkening shades

1.02 REFERENCES

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

B. ASTM
   1. G 21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to FungI.

C. NFPA
   1. 701-99 – Fire Tests for Flame-Resistant Textiles and Films.

1.03 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
   3. Storage and handling requirements and recommendations.
   4. Mounting details and installation methods.

B. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, and relationship to adjacent work.

C. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.

D. Samples:
   1. Selection Samples: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.
   2. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements. Shadecloth sample and aluminum finish sample as selected. Mark face of material to indicate interior faces.

E. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

F. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years experience in manufacturing products comparable to those specified in this section.

B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.

C. Fire-Test-Response Characteristics: Passes NFPA 701-99 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.

D. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

E. Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

F. Environmental Certification: Submit written certification from the manufacturer, including third party evaluation, recycling characteristics, and perpetual use certification as specified below. Initial submittals, which do not include the Environmental Certification, below will be rejected. Materials that are simply 'PVC free' without identifying their inputs shall not qualify as meeting the intent of this specification and shall be rejected.

G. Third Party Evaluation: Provide documentation stating the shade cloth has undergone third party evaluation for all chemical inputs, down to a scale of 100 parts per million, that have been evaluated for human and environmental safety. Identify any and all inputs, which are known to be carcinogenic, mutagenic, teratogenic, reproductively toxic, or endocrine disrupting. Also identify items that are toxic to aquatic systems, contain heavy metals, or organohalogens. The material shall contain no inputs that are known problems to human or environmental health per the above major criteria, except for an input that is required to meet local fire codes.

H. Recycling Characteristics: Provide documentation that the shade cloth can and is part of a closed loop of perpetual use and not be required to be down cycled, incinerated or otherwise thrown away. Scrap material can be sent back to the mill for reprocessing and recycling into the same quality yarn and woven into new material, without down cycling. Certify that this process is currently underway and will be utilized for this project.

I. Perpetual Use Certification: Certify that at the end of the useful life of the shade cloth, that the material can be sent back to the manufacturer for recapture as part of a closed loop of perpetual use and that the material can and will be reconstituted into new yarn, for weaving into new shade cloth. Provide information on each shade band indicating that the shade band can be sent back to the manufacturer for this purpose.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.07 WARRANTY

A. Roller Shade Hardware, Chain and Shadecloth: Manufacturer's standard non-depreciating twenty-five year limited warranty.

B. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Roller Shade Manufacturers: One of the following or approved equal:
   1. MechoShade Systems, Inc. Long Island City, NY.
   2. BTX Window Automation, Inc., Dallas, TX.
   3. Draper, Inc., Spiceland, IN.

2.02 MATERIALS

A. Roller Shade Schedule: Basis of Design: MechoShade Systems.
   1. Shade Type 1: Manual operating, chain drive, sunscreen roller shades in all exterior windows of rooms and spaces shown on the Drawings.
   2. Shade Type 2: Manual operating interior, chain drive room darkening roller shades with blackout fabric in all exterior windows of rooms and spaces shown on Drawings, and related mounting systems and accessories.
   3. Shade Type 3: Manual operating interior, chain drive "double" solar and room darkening blackout roller shades, operating independently of each other, in all exterior windows of rooms and spaces shown on Drawings, and related mounting systems and accessories.

B. Components:
   1. Shade Cloth:
      a. Visually Transparent Single-Fabric Shadecloth: MechoShade Systems, Inc., ThermoVeil group, single thickness non-raveling 0.030-inch (0.762 mm) thick vinyl fabric, woven from 0.018-inch (0.457 mm) diameter extruded vinyl yarn comprising of 21 percent polyester and 79 percent reinforced vinyl, in colors selected from manufacturer's available range.
         1) Open Linear Weave: "1800 series", 15 percent open, linear-weave pattern.
         2) Color: Selected from manufacturer's standard colors.

3) Other Manufacturers equivalent products.

b. Room darkening (PVC Free) Shadecloth with opaque acrylic backing: MechoShade Systems, Inc., "Equinox 0100 series", .008 inches thick (.19 mm) blackout material and weighing .94 lbs. per square yard, comprising of 53% fiberglass, 45% acrylic, 2% poly finish.
   1) Color: Selected from manufacturer's standard colors.

C. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.
   1. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.
   2. Shade band and Shade Roller Attachment:
      a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch (39.37 mm) in diameter for manual shades, and less than 2.55 inches (64.77 mm) for motorize shades are not acceptable.
      b. Provide for positive mechanical engagement with drive / brake mechanism.
      c. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" snap-off" spline mounting, without having to remove shade roller from shade brackets.
      d. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
      e. Any method of attaching shade band to roller tube that requires the use of: adhesive, adhesive tapes, staples, and/or rivets are not acceptable.

D. Shade Fabrication:
   1. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.
   2. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3.18 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design. Fabricate hem as follows:
      a. Concealed hemtube.
   3. Rubber bumpers.

E. Provide battens in standard shades as required to assure proper tracking and uniform rolling of the shadebands. Contractor shall be responsible for assuring the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, shall be responsible for establishing appropriate standards to assure proper tracking and rolling of the shadecloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.

F. For railroaded shadebands, provide seams in railroaded multi-width shadebands as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shadebands.

G. Provide battens for railroaded shades when width-to-height (W:H) ratios meet or exceed manufacturer's standards. In absence of manufacturer's standards, be responsible for proper use and placement of battens to assure proper tracking and roll of shadebands.

H. Blackout shadebands, when used in side channels, shall have horizontally mounted, roll-formed stainless steel or tempered-steel battens not more than 3 feet (115 mm) on center extending fully into the side channels. Battens shall be concealed in a integrally-colored fabric to match the inside and outside colors of the shadeband, in accordance with manufacturer's published standards for spacing and requirements:
   1. Battens shall be roll formed of stainless steel or tempered steel and concave to match the contour of the roller tube.
   2. Batten pockets shall be self-colored fabric front and back RF welded into the shadecloth. A self-color opaque liner shall be provided front and back to eliminate any see through of the batten pocket that shall not exceed 1-1/2 inches (38.1 mm) high and be totally opaque. A see-through moiré effect, which occurs with multiple layers of transparent fabrics, shall not be acceptable.

2.03 COMPONENTS

A. Access and Material Requirements :
   1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
   2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
   3. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and /or polyester, or reinforced polyester will not be acceptable.

B. Manual Operated Chain Drive Hardware and Brackets:
   1. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.
   2. Provide hardware capable for installation of a removable fascia, for both regular and/or reverse roll, which shall be installed without exposed fastening devices of any kind.
   3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.

4. Provide shade hardware system that allows for operation of multiple shade bands (multi-banded shades) by a single chain operator, subject to manufacturer's design criteria. Connectors shall be offset to assure alignment from the first to the last shade band.
5. Provide shade hardware system that allows multi-banded manually operated shades to be capable of smooth operation when the axis is offset a maximum of 6 degrees on each side of the plane perpendicular to the radial line of the curve, for a 12 degrees total offset.
6. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable.
7. Provide shade hardware constructed of minimum 1/8-inch (3.18 mm) thick plated steel or heavier as required to support 150 percent of the full weight of each shade.
8. Drive Bracket / Brake Assembly:
    a. MechoShade Drive Bracket model M5 shall be fully integrated with all MechoShade accessories, including, but not limited to: SnapLoc fascia, room darkening side / sill channels, center supports and connectors for multi-banded shades.
    b. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inch (9.525 mm) steel pin.
    c. The brake shall be an over -running clutch design which disengages to 90 percent during the raising and lowering of a shade. The brake shall withstand a pull force of 50 lbs. (22 kg) in the stopped position.
    d. The braking mechanism shall be applied to an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes an articulated brake assembly, which assures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated. Products that require externally applied lubrication and or not permanently lubricated are not acceptable.
    e. The entire M5 assembly shall be fully mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.

C. Drive Chain: #10 qualified stainless steel chain rated to 90 lb. (41 kg) minimum breaking strength. Nickel plate chain shall not be accepted.

D. Accessories
1. Fascia:
    a. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
    b. Fascia shall be able to be installed across two or more shade bands in one piece.
    c. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
    d. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
    e. Notching of Fascia for manual chain shall not be acceptable.
2. Room Darkening Side and / or Sill Channels:
    a. Extruded aluminum with polybond edge seals and SnapLoc-mounting brackets and with concealed fastening. Exposed fasting is not acceptable.

Channels shall accept one-piece exposed blackout hembar with vinyl seal to assure side light control and sill light control.

1) MechoShade side channels, 1-15/16 inches (49.2 mm) wide by 1-3/16 inches (30.1 mm) deep, two-band center channels, 2-5/8 inches (66.6 mm) wide by 1-3/16 inches (30.1 mm) deep. The 2-5/8-inch (66.6 mm) double-center channels may be installed at center-support positions of multi-band-shade ElectroShades. MechoShade side channels 2-5/8 inch (66.6 mm) may be used as center supports for ElectroShades; shadebands up to 8 high. For shadebands over 8 feet (2438 mm), provide ElectroShade side channels.
2) Color: To be selected from manufacturer’s standard colors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that condition of substrates are satisfactory for installation of products.

B. Take site measurements to verify adequacy of spaces for lockers.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow proper clearances for window operation hardware.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

D. Engage Installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems .

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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SECTION 13120

FIBERGLASS EFFLUENT TROUGHS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Rectangular fiberglass reinforced plastic troughs, weir plates, and support systems for installation in Return Activated Sludge (RAS) and Mixed Liquor (ML) Splitter Boxes.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. F101 - Standard for Contact-Molded, Fiberglass-Reinforced Plastic Wash Water Troughs and Launders.

B. ASTM International (ASTM):
   1. D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
   2. D570 - Standard Test Method for Water Adsorption of Plastics.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   5. D2583 - Standard Test Method of Indentation Hardness of Rigid Plastics by Means of Barcol Impresser.

C. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components - Health Effects.

1.03 SYSTEM DESCRIPTION

A. Trough manufacturer shall be responsible to design and provide the rectangular troughs to be installed in the RAS and ML Splitter Boxes as indicated on the Drawings.

B. Trough manufacturer shall be responsible to design and provide the entire support system for the troughs including structural support members, connections from troughs to supports, connections from troughs to concrete splitter box structure, lateral bracing, and all other support system accessories and connections required for a complete installation.

C. Install troughs in each Splitter Box as indicated on the Drawings.

D. Prior to fabrication of troughs and support systems, take measurements for installation of troughs and verify dimensions indicated on the Drawings. Ensure troughs and ancillary appurtenances fit within the available space.

E. Support systems shall be designed to not trap or hold water when the RAS Splitter Box or ML Splitter Box is drained.

F. Provide open-end connection at gullet wall and closed end at opposite end.

G. ML Splitter Box trough flow capacity:
   1. Capacity shall be 2,500 gallons per minute at the discharge gullet (with free discharge at the gullet).
   2. Trough shall have uniform weir water loading per linear foot of length.
   3. Maintain a minimum of 12 inches freeboard below the weir edge in the trough under maximum flow conditions.

H. RAS Splitter Box trough flow capacity:
   1. Capacity shall be 630 gallons per minute at the discharge gullet (with free discharge at the gullet).
   2. Trough shall have uniform weir water loading per linear foot of length.
   3. Maintain a minimum of 12 inches freeboard below the weir edge in the trough under maximum flow conditions.

I. Design ambient temperature conditions (wetted or dry): 20 to 105 degrees Fahrenheit.

J. RAS Splitter Box process water will be activated sludge, and ML Splitter Box process water will be mixed liquor.

K. The RAS and ML Splitter Boxes are fully exposed to sunlight and the weather and require UV resistance.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 – Submittals and the following requirements.

B. Shop drawings:
   1. Construction and erection details showing dimensions, attachments, support system details, and anchor bolt locations. Provide certified drawings.
   2. Complete description of components including troughs, weirs, anchoring materials, resins, catalysts, promotors, ultraviolet light inhibitors, and reinforcing materials.
   3. Instructions for handling, storage, and installation.
   4. Affidavit of compliance stating that material was manufactured, sampled, and inspected in accordance with AWWA F101.
   5. Suitable for use with in wastewater applications.

C. Calculations: Provide calculations sealed and signed by a professional structural engineer registered in the state where the project is located for the following:
   1. Seismic and wind design calculations for troughs, trough support system, and anchorage system for troughs-to-supports connections, supports-to-concrete connections, and seismic sloshing loads as specified and in accordance with Sections 01612 - Seismic Design Criteria.
   2. Calculations for trough stress and deflection under loadings in accordance with AWWA F101, and as specified.

D. Quality control submittals:
   1. Provide representative laminate samples. Samples shall be taken from plant production and shall be representative of actual construction, workmanship, appearance, and surface hardness.

2. Copies of laminate glass content test results from representative laminate samples including glass content and tensile/flexural test results.
3. Qualifications and experience of the trough manufacturer.
4. Inspection reports as specified under Source Quality Control.

E. Extended warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer: Manufacturer of similar fiberglass-reinforced plastic troughs for a minimum of 5 years on a minimum of 10 projects of similar applications.

B. References:
1. Provide references from a minimum of 3 installations currently operating with similar troughs in continuous service for a minimum of 3 years under similar operating conditions.
2. Reference information shall include location, service, contact person, and contact phone number.

1.06 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage, and handling shall be in accordance with manufacturer's instructions.

B. Package, ship, and store products to prevent warpage or distortion.

1.07 WARRANTY

A. Manufacturer shall provide a full limited warranty against defects in workmanship and materials, deflection, or defects in excess of standards specified, and in accordance with AWWA F101.
1. The warranty shall be provided for no less than 3 years and shall not be pro-rated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
1. F.B. Leopold Co., Inc.
2. Warminster Fiberglass.

2.02 MATERIALS

A. Troughs and weir plates:
1. Fabricated of premium grade fiberglass-reinforced polyester resin, with fiberglass constituting a nominal 30 percent by weight.
2. Inside surface of each trough shall have a smooth resin rich surface.
3. Outside surface of trough shall be resin sealed with no exposed glass fibers.
   a. Outside surface shall have smooth finish.
4. Color: Blue/green, molded-in with ultraviolet inhibitor.
5. Glass reinforcement: In accordance with AWWA F101.

6. Resin:
    a. Resin shall contain no fillers or additives except as follows:
        1) Fillers up to 2 percent by weight of a thixotropic agent may be used for viscosity control in the parafinated top coat provided it does not interfere with visual inspection or chemical resistance of the laminate.
        2) Resin may contain pigments, dyes, or colorants which have been determined by at least 5 years previous service to be acceptable for the service condition without fading or chalking from original color standard.
    b. The cure system used for the resins shall be in accordance with the resin manufacturer's current recommendations. All products shall be cured to at least 90 percent of the minimum Barcol hardness specified by the resin manufacturer.
    c. A separately cured, unreinforced gel coat shall not be used.
        1) No surface shall be acetone sensitive.
7. An ultraviolet stabilizer, 5 percent by weight, shall be added to all exposed surfaces.

B. Integral longitudinal stiffening ribs: Materials shall be free of rust, oil, and any foreign matter.

C. All support systems and hardware complete, including structural steel, bolts, nuts, washers, straps:
    1. Type 316 stainless steel.
    2. Stainless steel structural supports shall be manufactured as specified in City of Austin No. 721S - Structural Steel.
    3. Anchor bolts and concrete anchors: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.03 TROUGH AND WEIR PLATE CHARACTERISTICS

A. Troughs shall be manufactured as follows:
    1. Flat bottoms and vertical sides, unless otherwise indicated on the Drawings.
    2. Top edges of trough before addition of weir plates shall be level, straight, and parallel with a tolerance of no more than 1/8-inch deviation from true plane measured when the trough is unloaded.
    3. Laminate construction and design: In accordance with AWWA F101 and the following:
        a. Minimum thickness of structural layer:
            1) As required to meet the design requirements specified, or 1/4-inch minimum (whichever is thicker).
            2) Fabricate within a tolerance of 1/16 inch. In no cases shall the thickness be less than 3/16 inch.
    4. Thickness of laminate at all supports such as saddles shall be at least 150 percent of the nominal thickness of the trough.
    5. End flanges and blind ends shall be minimum of 1.5 times the nominal thickness of the trough.
    6. Where troughs are grouted into or passes through a wall, provide integrally molded water stop.

7. Provide longitudinal stiffening ribs shall be integrally molded on the outside of the troughs to ensure rigidity.
    a. Longitudinal stiffening ribs shall be constructed of metal reinforcing materials completely encapsulated with a minimum of 1/8-inch thick laminate extending a minimum of 2 inches beyond the metal reinforcing material.
8. Laminate cuts, slots, and holes for attachment of weir plates: Resin sealed in accordance with AWWA F101.

B. Minimum physical properties for 1/4-inch laminate thickness at 73 degrees Fahrenheit:
1. Tensile strength (ASTM D638): 12,000 pounds per square inch.
2. Flexural strength (ASTM D790): 19,000 pounds per square inch.
3. Flexural modulus (ASTM D790): 900,000 pounds per square inch.
4. Barcol hardness (ASTM D2583): 35 minimum.
5. Izod notched impact (ASTM D256): 13 foot-pounds per inch.
6. Water absorption (24 hour) (ASTM D570): 0.2 percent maximum.

C. Troughs and weirs shall be suitable for use in wastewater.

D. Troughs and weirs shall be in accordance with AWWA F101.

E. Weir plates:
1. Provide weir plates with slotted holes spaced at a maximum of 6 inches on center to facilitate a minimum vertical adjustment of plus or minus 1/2 inch.
2. Constructed of the same material as the troughs.
3. Minimum 1/4-inch thick.
4. Factory assembled and shall be attached with Type 316 stainless steel bolts, nuts, and washers as indicated on the Drawings.
5. Laminate cuts, slots, and holes: Resin sealed in accordance with AWWA F101.

F. Spacer rods:
1. Sufficient plastic spacer rods shall be included to maintain a uniform width over the length of trough.
2. Spacer rods shall be spaced to prevent buckling and to provide maximum resistance to water loading on the sidewall of the trough.

2.04 TROUGH AND SUPPORT SYSTEM DESIGN

A. Support system:
1. Design to allow minimum 1-inch vertical and horizontal adjustment of the trough.

B. Troughs:
1. Design end flanges and blind ends to be a minimum of 1.5 times the nominal thickness of the trough, conforming to the fiber stress limitations as specified, and designed for anchorage loadings.
2. Fiber stress limitations:
    a. Design troughs for maximum wall stress under the most severe loading conditions to be less than or equal to 1,500 pounds per square inch in accordance with AWWA F101.

b. Stress shall be calculated for the fiberglass only and shall not include any additional embedded reinforcing materials.
c. This stress criterion is equivalent to an 8:1 safety factor as applied to the tensile and flexural properties of contact-molded troughs and launders.

3. Deflection under load: Maximum upward or downward vertical deflection under full buoyant or gravity loads shall be less than or equal to L/1,000 where L is defined as the unsupported trough length in inches. Maximum vertical deflection, measured at mid-point between trough supports, shall not exceed 3/16 inches.
4. Maximum trough sidewall horizontal deflection under full lateral load shall be less than or equal to D/100, where D is defined as the trough depth in inches.
   a. Under no circumstances shall the maximum sidewall deflection exceed 3/16 inches.
5. Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to W/100, where W is defined as the tough width, in inches.
   a. Under no circumstances shall the maximum bottom deflection exceed 3/16-inch.

C. Design troughs, support systems, and anchors in accordance with the following loadings, and in accordance with specified stress and deflection limitations:
   1. Seismic loadings per seismic design criteria for troughs, supports, and anchors shall be as specified in Section 01612 - Seismic Design Criteria.
      a. Include design for seismic induced sloshing water loads.
   2. Gravity load: Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as weir plates and the spreader bars, together with the weight of water to fill and submerge the trough to the water surface elevation indicated on the Drawings.
      a. Any additional loads, such as piping, etc., shall also be considered.
   3. Buoyant load:
      a. The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected).
      b. The line of action passes through the centroid of the submerged cross-sectional area.
   4. Lateral load:
      a. Loads acting against the trough side walls, specifically those induced by differential water levels on either side of the trough walls.
      b. The maximum possible differential, existing when the tough is empty and the tank is full, or when the trough is full and the tank is empty, shall be used when calculating deflection fiber stress.
      c. Include sloshing load due to seismic forces on both the trough and the support system.
   5. Thermal stresses:
      a. Design troughs to accommodate thermally induced stresses resulting from differences in coefficients of thermal expansion (and contraction) between the trough and tank/support materials.
      b. Design the troughs and support systems to accommodate no less than 1/8-inch trough movement per 20 feet length of trough over temperature range as specified, without exceeding the deflection or strain limitation set forth in referenced standards, and as specified.

D. Torsional stability:
   1. The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges.
   2. The maximum torsional oscillation shall be in accordance with AWWA F101.
   3. Provide trough-to-trough and wall-to-wall stabilizers as required to prevent torsional oscillation, and at a minimum in accordance with AWWA F101.
   4. Any or all of the following trough stabilization techniques shall be considered:
      a. Trough-to-trough stabilization (or trough-to-support truss bracing).
      b. Torsional stiffeners within trough.
      c. Support spacing and rigidity.
      d. Internal baffles and/or flow straighteners.

2.05 SOURCE QUALITY CONTROL

A. Trough and weir plates finish and appearance shall meet requirements in accordance with AWWA F101.
   1. Furnish inspection reports for finish and appearance for fabricated trough and weir laminates.

B. Furnish affidavit that material was manufactured, sampled, and inspected in accordance with AWWA F101.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

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

B. Protect appurtenances and existing concrete coatings from damage during trough installation.

C. All holes, and other cut surfaces shall be sanded smooth and resin sealed.

D. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer, and as indicated in the Contract Documents.

E. Set in place with weir edges to elevations indicated on the Drawings.

F. Troughs shall be aligned and leveled, free of warp or twist, with no greater than 1/32-inch variation between any 2 points on the weir edge.
   1. Across individual splitter boxes, align trough weirs to within plus or minus 1/16 inch of each other.

G. Grout in place after leveling.

H. RAS and ML Splitter Box slide gates shall be individually isolated to check trough elevation tolerances one at a time.

I. Observe and inspect troughs for deflection, oscillation, cracks, blisters, surface porosity, chips, delamination, or other defects.
   1. Correct any deficiencies.

3.03 ADJUST AND CLEAN

A. Clean all trough surfaces after installation in accordance with manufacturer's instructions.

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

END OF SECTION

SECTION 13122

METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Prefabricated metal building systems.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

B. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

C. American Iron and Steel Institute (AISI):
   1. SG02 - North American Specification for the Design of Cold-Formed Steel Structural Members.

D. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
   4. A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   5. A792 - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
   6. B187 - Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.
   7. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   8. D1494 - Standard Test Method for Diffuse Light Transmission Factor of Reinforced Plastics Panels.
   9. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
   10. F436 - Standard Specification for Hardened Steel Washers.
   11. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.3 - Structural Welding Code - Sheet Steel.

F. FM Global (FM).

G. International Accreditation Service (IAS):
   1. AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems.

H. Metal Building Manufacturing Association (MBMA):
   1. Metal Building Systems Manual.

I. Occupational Safety and Health Administration (OSHA):
   1. Occupational Safety and Health Standards:
      a. 1910.23 - Guarding floor and wall openings and holes.

J. Research Council on Structural Connections (RCSC):
   1. Specification for Structural Joints Using High Strength Bolts.

K. Society for Protective Coatings (SSPC):
   1. SSPC-SP2 - Hand Tool Cleaning.

L. Steel Door Institute (SDI):
   1. A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

M. Underwriters' Laboratories, Inc. (UL).
   1. 580 - Tests for Uplift Resistance of Roof Assemblies.

1.03 DEFINITIONS

A. Primary framing: An assemblage of beams and columns that support the secondary framing members, and that collects loads to transfer to the building foundation.

B. Secondary framing: Members which directly support roof, wall, or floor surfaces and convey loads to the primary framing.

1.04 SUBMITTALS

A. Product Data:
   1. Manufacturer's installation instructions.
   2. Manufacturer's standard color charts and profiles:
      a. Exterior wall and roof panels.
      b. Interior wall and roof liner panels.
      c. Gutters and downspout trim.
   3. Manufacturer's list of approved clamps that may be used to hang suspended items from roof purlins and details of acceptable methods of attachment to purlins.

B. Shop drawings:
   1. Shop drawings: Catalog cuts; design and erection drawings; and other data needed to clearly describe design, materials, construction details, fasteners, and erection.
      a. Erection drawings shall include building dimensions, required foundation footprint, anchor bolt and base plate settings, bracing, main and secondary framing, and sections and details required to fully describe construction of building.

b. Indicate quantity, size, grade, embedment, and projection, and location of anchor bolts.

2. Calculations: Submit engineering design calculations for the complete structural system,, sealed and signed by a Professional Engineer licensed in the state where the project is located.
   a. Clearly indicate foundation reactions at all columns. Identify all applied loads, load factors, and load combinations used to develop the reactions.
   b. Calculations will be submitted for record information only.
      1) Engineer's review of calculations will be for general conformance to the loading requirements of this Section.
      2) The building manufacturer shall remain fully responsible for the structural design and adequacy of the metal building system.
3. Descriptive data: Submit data for the following items either on the shop drawings or separately: Accessories, each type of flashing, trim closures, caps and similar items, fasteners, doors, roof openings, gutters, and downspouts.

C. Quality control submittals:
   1. Building manufacturer:
      a. If requested by the Engineer, submit a record of manufacturer's metal building systems of similar design manufactured and erected in the 5-year period preceding the bid date for this project.
         1) Include date of installation, location of metal building, and name and address of Owner.
      b. Submit evidence of manufacturer's certification under IAS AC472 Accreditation.
         1) Certification must be valid for the facility at which the metal building will be fabricated.
      c. Confirmation of UL 580 wind uplift rating.
   2. Erector:
      a. Submit welder qualification certificates.

D. Record documents:
   1. 1 set of reproducible "Record Drawings" for the erected structure.
      a. Drawings shall bear the seal and signature of a Professional Engineer, registered in the state where the work is constructed and who provided responsible charge for the design.

E. Closeout submittals: Submit Contract Closeout Submittals as specified.
   1. Operating and Maintenance Information.
   2. Warranty.
   3. Certificate of Compliance: At the completion of the metal building manufacture, the manufacturer will furnish a letter to the Engineer stating that the work was performed in accordance with the approved construction documents.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer shall have been engaged in the design, manufacture, and erection of metal building systems of the type specified for at least 5 years preceding the Bid Date of this Contract.
   1. Building manufacturer shall be certified by IAS AC472 Accreditation.
   2. The manufacturer's Engineer of Record shall hold current license as a Professional Engineer in the state where the work will be constructed.

B. Erector qualifications: Erectors shall be trained, approved, and certified by the manufacturer prior to Bidding of the Project. Erectors shall demonstrate at least 3 years of experience in successfully erecting metal building systems of the type specified in Section 01610 - Project Design Criteria.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver materials and fabrications to the job site in manufacturer's original containers with seals unbroken and labeled with manufacturer's identification and number.

B. Delivery:
   1. Deliver materials dry and undamaged, and store out of contact with ground.
   2. Cover materials with weathertight coverings and keep dry.
   3. Provide good air circulation and protection from surface staining for roof and wall covering sheets.

C. Storage and protection: Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

1.07 WARRANTY

A. Provide Owner with warranty that exterior finish system for metal panels shall be guaranteed against blister, peeling, cracking, chipping, or material rust-through for a period of 1 years from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Buildings: One of the following or equal:
   1. American Buildings Co.
   2. Behlen Building Systems.
   3. Butler Manufacturing Co.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. System:
   1. Design: Furnish metal building with vertical walls, gable roof, and with column layout as indicated on the Drawings.
   2. Size:
      a. Furnish metal building of the size and configuration indicated on the Drawings.
      b. Coordinate manufacturer's design dimensions for metal building system components, including columns, with equipment foundations, and details indicated on the Drawings.
   3. Roof slope: Use a roof slope of 1 inch vertical in 12 inches horizontal or steeper.
   4. Provide building with horizontal and vertical bracing where indicated on the Drawings.
   5. Column reactions shall be vertical and horizontal only.
      a. No bending moments shall be transferred at column bases.

6. Building indicated on the Drawings is a roof canopy only.
    a. Wall framing and wall panels will not be provided under this contract; however, design the structural framing and report frame reactions to accommodate both the present condition, and the possibility of adding wall panels to enclose the structure at a future date.
7. The building roofing system will be listed for a UL 580, Class 60 designation.
8. Openings: Frame openings for doors, windows, louvers, equipment with structural framing to replace panels and secondary framing cut for opening.
    a. Provide curbs to suit roof-mounted equipment compatible with roof sheathing.

B. Performance requirements:
1. General:
    a. Design of the metal building structure and its appurtenances shall conform to the requirements of the IBC, the Metal Building Systems Manual, and the requirements of this Section.
        1) Where the Metal Building Systems Manual conflicts with the requirements of this Section, the more restrictive requirements will govern.
    b. Do not include collateral or auxiliary loads in load combinations where dead loads offset other load effects (for example, uplift due to wind loads).
    c. Hot-rolled structural steel sections or welded-up plate sections: Design in accordance with AISC 360.
    d. Cold-formed steel structural members: Design in accordance with the AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
2. Loading:
    a. General:
        1) Design building for dead load, live loads, and combinations of loads including unbalanced loads in accordance with the IBC and the MBMA Metal Building Systems Manual, except as modified in this Section.
        2) Reduction in wind, live, or snow loads based on tributary loaded area will not be permitted.
    b . Roof loading requirements:
        1) Live load: Minimum 20 pounds per square foot assumed to act vertically on horizontal projected area of roof.
        2) Ground snow load: Minimum 5 pounds per square foot assumed to act vertically on horizontally projected area of roof.
        3) Rain on snow surcharge load: Minimum 5 pounds per square foot assumed to act vertically on horizontally projected area of roof.
    a. Collateral loading: Uniform roof load of 10 pounds per square foot assumed to act vertically on horizontal projected area of roof to account for miscellaneous accessories supported from the structure.
        1) Collateral loading shall be considered a live load.
        2) Design primary and secondary framing to support the additional weight of mechanical equipment such as fans, air conditioners, etc. shown on plans.
            a) Mechanical equipment weights are in addition to collateral loading.

b. Auxiliary loading:
    1) Structural members: Any single point along the secondary roof framing members shall be designed to carry a concentrated load of 200 pounds in addition to the roof live load.
    2) Roof panels: Design panels to support a 200 pound load uniformly distributed over a 2 square foot area centered between supporting framing members, without exceeding a panel deflection to span ratio of 1/180 in a 2-span condition.
    3) Auxiliary loading shall be considered a live load.
    4) Auxiliary is to be considered concurrently with collateral loading.
c. Wind loading requirements: As specified in Section 01614 - Wind Design Criteria.
    1) Design roof purlins and structural frames for loads specified, but not less than 20 pounds per square foot uplift on horizontally projected roof area.
d. Seismic loading requirements: As specified in Section 01612 - Seismic Design Criteria.
    1) Bolted joints subject to seismic loading shall be designated pretensioned joints.

4. Deflection limitations:
    a. Primary frames:
        1) Gravity deflection:
            a) Live load deflection: L/240.
            b) Snow load deflection: L/240.
            c) Total load deflection: L/240.
        2) Horizontal drift of rigid frames measured at eave :
            a) Seismic drift limitation: N/A.
            b) Wind drift limitation: H/60.
    b. Secondary framing:
        1) Gravity deflection:
            a) Live load deflection: L/180.
            b) Snow load deflection: L/180.
            c) Total load deflection: L/180.
        2) Horizontal deflection: L/180.
    c. Deflection of roof and wall panels: Span/180.
    d. Deflection calculations should be based on the wind loads presented in AISC Design Guide 3.
        4) Deflection calculations should be based on the unreduced wind loads required in the IBC (50-year reoccurrence intervals).
5. Climatic conditions:
    a. Gutters and downspouts: Design for a rainfall rate of 5 inches per hour.
    b. Temperature: Provide for movement (expansion or contraction) caused by a range of ambient temperature of 120 degrees Fahrenheit without detrimental effects.

2.03 MATERIALS

A. Primary framing (rigid frames):
    1. Welded plates or hot-rolled steel columns and roof beams, complete with necessary splice or connector plates for bolted field assembly.
        a. Minimum nominal thickness of structural shapes or their elements shall be 1/4-inch.

2. Welding procedures, welder qualifications, and welding quality standards shall be in accordance with AWS D1.1 and AWS D1.3.
3. Base, cap, compression plates, and stiffener plates shall be factory-welded in place, and shall have shop-fabricated connection holes.
    a. Provide minimum 4 anchor bolts per column base.
4. Columns and roof beams shall be fabricated complete with holes in webs and flanges for attaching bracing and roof and sidewall framing.
5. Shop finishing:
    a. Shop primed for field painting:
        1) Clean ferrous surfaces of oil, grease, loose rust, loose mill scale, and other foreign substances, in accordance with the SSPC-SP2.
        2) Apply 1 coat of shop primer in accordance with SSPC Paint Specification No. 15.
            a) Remove shop primer as specified in Section 09960 - High-Performance Coatings prior to field coating.
    b. Shop galvanized - hot-dipped:
        1) Hot-dip galvanize members in accordance with ASTM A123.
        2) Provide a minimum zinc coating of not less than 1.4 ounces per square foot.

B. Secondary framing (purlins, girts, framing at endwalls and openings, eave struts, bracing):
1. Hot rolled structural steel or cold-formed members.
2. Minimum thickness: 16-gauge.
3. Bracing elements constructed of wire rope, stranded tendons, or other similar material is not permitted.
    a. Rolled angle sections or solid steel bar is permitted.
4. Provide factory-punched holes for panel connections.
5. Shop finishing - hot rolled sections:
    a. Shop-primed for field painting:
        1) Clean ferrous surfaces of oil, grease, loose rust, loose mill scale, and other foreign substances, in accordance with the SSPC-SP2.
        2) Apply 1 coat of shop primer in accordance with SSPC Paint Specification No. 15.
            a) Remove shop primer as specified in Section 09960 - High-Performance Coatings prior to field coating.
    b. Galvanized - hot-dipped:
        1) Hot-dip galvanize members in accordance with ASTM A123.
        2) Provide a minimum zinc coating of not less than 1.4 ounces per square foot.
6. Shop finishing (cold-formed sections):
    a. Shop primed for field painting:
        1) Clean ferrous surfaces of oil, grease, loose rust, loose mill scale, and other foreign substances, in accordance with the SSPC-SP2.
        2) Apply 1 coat of shop primer in accordance with SSPC Paint Specification No. 15.
            b) Remove shop primer as specified in Section 09960 - High-Performance Coatings prior to field coating.
    b. Galvanized - hot-dipped:
        1) Hot-dip galvanize members in accordance with ASTM A653 to G90 designation.

C. Roof and wall panels:
   1. Roll-formed minimum 24-gauge steel, factory-finished each side.
   2. Panels shall have interlocking side seams and shall be the manufacturer's maximum standard width Factory cut to maximum possible length to minimize end laps.
   3. Factory pre-punched for fastening.
   4. Panel finish:
      a. Factory pre-painted, pre-finished coating consisting of a UV light-resistant polyvinylidene diflouride (PVDF) resin based paint and primer system having a total thickness not less than 1.0 mil on an approximately 55 percent aluminum-43 percent zinc-1 percent silicone galvanized coating complying with ASTM A792.
      b. The galvanized coating shall be deposited at a minimum rate of 0.50 ounces/square foot.
      c. Furnish manufacturer's standard color chart for Owner's selection.
   5. Ridge panel: 1-piece, factory-formed to match roof slope at each side, of same material as roof panels, and capable of completely sealing roof ridge.

D. Bolted joint components: High-strength steel bolts used for steel-to-steel structural connections.
   1. Bolts: ASTM F3125, Grade A325, Type 1.
   2. Nuts: ASTM A563, heavy hex. Grade and finish to match bolts as specified in RCSC Specification for Structural Joints Using High Strength Bolts.
   3. Washers: ASTM F436; flat unless otherwise noted.
   4. Load indicator devices:
      a. Twist-off type tension-control bolt assemblies: ASTM F3125, Grade A1852**.**
      b. Compressible washer direct tension indicators: ASTM F959, Type 325-1 for ASTM F3125, Grade A325 bolts.
   5. Bolts furnished for the project shall be a single size and grade.

E. Anchor bolts or anchor rods: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry except that material shall be hot-dip galvanized carbon steel unless otherwise indicated on the Drawings.

F. Fasteners and washers:
   1. Fasteners and washers used for attachment of wall and roof panels.
   2. Fasteners: Vinyl-coated steel or stainless steel.
   3. Washers: Neoprene or other accepted type washer capable of being used to ensure watertightness at fastening locations.

G. Gutters and downspouts:
   1. 24-gauge steel.
   2. Galvanized in accordance with ASTM A653 to G90 designation.
   3. Field painted. Color to be selected by Owner to complement wall panels.

H. Doors and frames:
   6. Provide hinged doors in accordance with published recommendations of SDI A250.8.
      a. Doors and frames shall be Level III.
   7. Provide each door with a heavy-duty, corrosion-resistant, cylinder lock set to match locks on Master Key System.

8. Provide weatherstripping and threshold for exterior doors.

I. Windows and glazing:
   1. Provide windows and glazing as indicated on the Drawings

J. Roof hatch: Provide roof hatch as indicated on the Drawings and as specified in Section 07722 - Roof Hatches.

K. Touch-up painting materials:
   1. For structural elements:
      a. Shop primer: Manufacturer's standard primer.
      b. Touch-up paint: Same as shop primer.
   2. For sheet metal skin:
      a. Exterior finish paint: Match specified coating.
         1) Color: Color as selected by the Engineer.

L. Insulation:
   1. Thermal value:
      a. Roof insulation: As defined in Table 502.2(2) of the IECC.
      b. Wall insulation: As defined in Table 502.2(2) of the IECC.

M. Translucent panels:
   1. Exterior ribbed profile sheet plastic manufactured with light stabilized polyester resins and reinforced with glass fibers.
      a. Glass fibers shall be approximately 30 percent by weight.
   2. Panels shall be resistant to chemicals expected in or around the structure.
   3. Panels at roof must be capable of withstanding a 200 lb point load as required by OSHA 1910.23(e)(8), without the use of wire screens or external guardrail systems.
   4. Exterior panels shall match the configuration of the metal roofing.
   5. Color shall be as selected by the Engineer.
   6. Panels shall be classified by UL and FM with a flame spread of 25 or less and be self-extinguishing for fire.
   7. Minimum light transmittance in accordance with ASTM D1494 shall be 24 percent.

N. Caulking material: Elastomer type, manufacturer's standard.

O. Roof vents:
   1. 10-foot ridge vents with 9-inch or 12-inch throat opening at ridge. Vents shall be pre-fabricated by a recognized manufacturer and shall include necessary flashing to make them weathertight.
   2. Factory painted with color acceptable to Engineer and factory assembled units complete with bird screen and cord operated damper.
   3. Each vent shall allow a minimum of 620 cubic feet per minute air movement at a temperature differential of 10 degrees.
   4. Vents shall be fabricated by a recognized manufacturer shall include necessary flashing to make them weathertight.

P. Vent materials:
   1. Steel: Minimum 20 gauge galvanized.
   2. Screens: 1/8-inch mesh aluminum screen.

Q. Ventilator accessories:
    1. Bird Screen.
    2. Flashing.

2.04 FABRICATION

A. Shop fabrication:
    1. Structural elements:
        a. Fabricate rigid frame of hot-rolled sections or continuously welded plate sections.
        b. Field connections shall be bolted unless otherwise accepted by the Engineer.
    2. Wall panels:
        a. Provide panels that are 1 piece from base to eave and have fasteners located on inside of panels**.**
        b. Provide top and bottom closures and bottom supports.
    3. Roof panels:
        a. Panel splicing: Panels may be spliced with minimum end overlap of 9 inches at purlins.
        b. Ridge panel: Provide 1 piece ridge panel, factory formed to match roof slope, of same material as roof panel, and capable of completely sealing roof ridge.
        c. Expansion of roof panels: Provide means to allow expansion of roof panels.
    4. Fasteners for roof and wall panels:
        a. Fasteners: Secure with fasteners that ensure maximum weathertightness, proper bearing surface, and permanent seal at point of fastening.
        b. Washers: Use washers capable of assuring watertightness at fastening locations.
    5. Accessories:
        a. Gutters, downspouts, and hangers:
            1) Provide 4-inch gutters, downspouts, and hangers as indicated on the Drawings.
        b. Vents:
            1) Provide vents of size and location indicated on the Drawings.
            2) Provide louvers that are operable and that have screens.
        c. Ventilators:
            1) Provide buildings with gravity vertical turbine ventilators with 12-inch throats where indicated on the Drawings.
            2) Provide ventilators that are gravity operated with damper.
            3) Accessories: Provide hardware and accessories including bird screen and flashing, as required to properly install ventilators in roof openings.

B. Tolerances:
    1. Hot-rolled sections: In accordance with AISC 303.
    2. Cold-formed and Built-up sections: In accordance with MBMA Metal Building Systems Manual.

2.05 SOURCE QUALITY CONTROL

A. General.
   1. Components of the metal building system fabricated in the manufacturer's shop will not be subject to special inspection, as specified in this Section.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Verify site conditions prior to start of work. Unacceptable conditions shall be reported to Engineer.
   2. Starting of erection of metal building system work shall indicate acceptance of existing conditions.
      a . Manufacturer or manufacturer's trained erector shall review and examine existing site conditions, foundation, and surface preparation, and adequacy of site-prepared components prior to commencing erection of the building.

3.02 ERECTION

A. General:
   1. Erect in accordance with the MBMA, Metal Building Systems Manual and manufacturer's instruction, except as modified in this Section.
   2. Separate dissimilar materials with gaskets or suitable insulating coatings.
   3. Keep exposed surfaces clean and free from sealant, metal cuttings, and other foreign materials.

B. Framing and structural members:
   1. Set anchor rods by template and securely tie into formwork before concrete placement.
   2. Provide uniform bearing under baseplates and sills by filling using a nonshrinking grout as specified in Section 03600 - Grouting.

C. Walls and roof:
   1. Erect a structure that will be free from water leaks and meet design requirements.
   2. Direct side lap edges away from the prevailing winds at the site.
   3. Do not exceed the maximum fastener spacings specified.
      a. Space fasteners uniformly not to exceed: 8 inches on center at ends of covering, 12 inches on center at intermediate supports and at roof covering side laps, and 18 inches on center at wall covering side laps.
   4. Install fasteners in straight lines within a tolerance of 1/2-inch per bay.
   5. Seal side laps, ends of roof, wall coverings, and joints at accessories.
      a. Drive fasteners to the surface and seat gasketed heads and washers.
   6. Fasten accessories to framing members, except as otherwise accepted by the Engineer.
   7. Wall panels shall be isolated from concrete floor slab and/or foundation.
   8. Flashing shall be provided at the base of wall panels to prevent wind-driven rain from entering the building envelope.

D. Gutters and downspouts:
   1. Attach securely to the building.
   2. Install gutters sloped to drain with adequate provisions for expansion and contraction.

E. Doors and roof openings:
   1. Anchor securely to the supporting construction.
   2. Install doors plumb and true and adjust to provide operation.

3.03 FIELD QUALITY CONTROL

A. General:
   1. Installation of metal building system will be subject to special inspection and evaluation during construction, as specified in this Section.

B. Site inspection:
   1. Special inspection of the metal building system components will be performed at the time and frequency outlined in Schedule 13-1.
   2. The elements of the metal building system construction that will be subject to special inspection are as indicated in Attachment 13-1.

3.04 ADJUSTING

A. Touch-up factory finished surfaces of roof and wall panels with the manufacturers recommended paint where damaged or abraded.

B. Where shop processes such as shearing or punching leave edges of galvanized steel unprotected by galvanization, touch up unprotected edges as specified in this Section.

C. Galvanized surfaces: Repair damaged galvanized surfaces in accordance with recommendations of the American Hot-Dip Galvanized Association.

3.05 CLEANING

A. Remove excess materials, equipment, and debris incidental to this work upon completion.

3.06 PROTECTION

A. During erection, the erector shall be responsible for the protection of this and all adjacent work from damage.

END OF SECTION

SCHEDULE 13-1 METAL BUILDING SYSTEM CONSTRUCTION SPECIAL INSPECTION			
IBC Table 1704.3	**Inspection Task**	**Frequency/Timing of Inspection**	**Criteria Reference**
Prior to beginning installation of metal building, verify high-strength bolts, nuts, and washers:			
1.a.	Identification markings conform to ASTM standards required by approved design.	**Periodic:** Confirm from stockpile of materials delivered to site whether material furnished complies with the materials in the approved design.	
1.b.	Confirmation of manufacturer's certificate of compliance	Periodic: Confirm that manufacturer has furnished the required Certificate of Compliance.	
Inspection of high-strength bolted joints:			
2.a.	Joints designated bearing-type connections by the approved design.	**Periodic:** Provide **continuous** inspection of the initial installation of each type and size of joint. Subsequent installations of the same type and size of joint may be inspected on a **periodic** basis with inspections of a minimum of **20%** of installations, or once per calendar week, whichever is more frequent.	
2.b.	Joints designated slip-critical connections by the approved design.	**Continuous:** Provide **continuous** inspection as specified in Section 01455 - Regulatory Quality Assurance.	
Inspection of structural steel welding:			
5.a.1.	Complete and partial penetration groove welds.	**Continuous**: Provide **continuous** inspection as specified in Section 01455 - Regulatory Quality Assurance.	
5.a.2.	Multipass fillet welds.	**Continuous**: Provide **continuous** inspection as specified in Section 01455 - Regulatory Quality Assurance.	
5.a.3.	Single-pass fillet welds greater than 5/16 inch.	**Continuous**: Provide **continuous** inspection as specified in Section 01455 - Regulatory Quality Assurance.	

SCHEDULE 13-1 METAL BUILDING SYSTEM CONSTRUCTION SPECIAL INSPECTION			
IBC Table 1704.3	**Inspection Task**	**Frequency/Timing of Inspection**	**Criteria Reference**
5.a.4.	Single-pass fillet welds less than or equal to 5/16 inch.	**Periodic:** Provide **continuous** inspection of the initial production of each type and size of welded joint. Subsequent production of the same type and size of joint may be inspected on a **periodic** basis with inspections of a minimum of **20%** of installations, or once per calendar week, whichever is more frequent.	
5.a.5.	Floor and roof deck welds.	**Periodic:** Provide **continuous** inspection of the initial production of each type and size of welded joint. Subsequent production of the same type and size of joint may be inspected on a **periodic** basis with inspections of a minimum of **20%** of installations, or once per calendar week, whichever is more frequent.	
Inspection of steel frame joint construction for compliance with approved design.			
6.a.	Bracing and stiffening details.	**Periodic:** Provide **periodic** inspection of any bracing and stiffening details of construction. Inspection should include, as a minimum, verification of member sizes and proper orientation. A minimum of **15%** of locations should be verified.	
6.b.	Member locations.	**Periodic:** Provide **periodic** inspection of member locations. Inspection should include, as a minimum, verification of member sizes and proper spacing/location. A minimum of **15%** of locations should be verified.	
6.c.	Connection joint details.	**Periodic:** Provide **periodic** inspection of joint details of construction. Inspection should include, as a minimum, verification of miscellaneous steel detailing, including stiffener plates, concrete pourstops, gusset plates and similar miscellaneous steel framing. A minimum of **15%** of locations should be verified.	

Attachment 13-1

METAL BUILDING CONSTRUCTION REPORT

Project Name

Owner

Permit No.:		Structure:	
Date:		Weather:	
Contractor:		Min/Max Temp:	
Dwg. Ref:			
Location:			

ELEMENT DESCRIPTION	TABLE 1704.3	CONFORMS
High strength bolts, nuts, and washers		
General:		
Fastener components are protected in closed containers from dirt and corrosion.	1.a.	❑Yes ❑No
Fastener components that accumulate dirt or rust may not be cleaned and Inc. into work.	1.a.	❑Yes ❑No
Fasteners may not be reused.	1.a.	❑Yes ❑No
Material within the grip of the bolt is non-compressible steel.	1.a.	❑Yes ❑No
Burrs extending greater than 1/16-inch above the faying surface are removed.	1.a.	❑Yes ❑No
Materials:		
Bolt grade: ❑ F3125, Grade A325 ❑ F3125, Grade A490 ❑ F3125, Grade F1852 “twist off” ❑ F3125, Grade F2280 “twist off” Other:_____	1.a.	❑Yes ❑No

ELEMENT DESCRIPTION	TABLE 1704.3	CONFORMS
Bolt size: ❑ 5/8 inch ❑ 3/4 inch ❑ 7/8 inch ❑ 1 inch ❑ 1 1/8 inch ❑ 1 1/4 inch ❑ Other _____	1.a.	❑Yes ❑No
Bolt finish: _____	1.a.	❑Yes ❑No
Nut grade: ❑ A194 ❑ A563 ❑ Other: _____	1.a.	❑Yes ❑No
Nut finish: _____	1.a.	❑Yes ❑No
Washer grade: ❑ F436 ❑ F959	1.a.	❑Yes ❑No
Washer finish: _____	1.a.	❑Yes ❑No
Hole: ❑ Standard ❑ Oversized ❑ Short-slotted ❑ Long-slotted		❑Yes ❑No
Bearing Type Joints:		
Faying surfaces may be uncoated, coated, or galvanized.	2.a.	❑Yes ❑No
All plies of joint have been drawn into firm contact	2.a.	❑Yes ❑No
Pre-tensioned Joints:		
Faying surfaces may be uncoated, coated, or galvanized.	2.a.	❑Yes ❑No
Pre-installation verification of fastener assembly and installation procedures	2.a.	❑Yes ❑No
Bolts tightened in joint in accordance with Section 8 of RCSC Specification for Structural Joints Using High Strength Bolts	2.a.	❑Yes ❑No
		❑Yes ❑No
Slip Critical Joints:		
Faying surfaces are not coated	2.b.	❑Yes ❑No
Faying surfaces to be coated have been prepared in accordance with RCSC Specification for Structural Joints Using High Strength Bolts	2.b.	❑Yes ❑No
Galvanized faying surfaces have been prepared in accordance with RCSC Specification for Structural Joints Using High Strength Bolts	2.b.	❑Yes ❑No
Pre-installation verification of fastener assembly and installation procedures	2.b.	❑Yes ❑No
Bolts tightened in joint in accordance with Section 8 of RCSC Specification for Structural Joints Using High Strength Bolts	2.b.	❑Yes ❑No
Welding of Structural Steel		
General:		

ELEMENT DESCRIPTION	TABLE 1704.3	CONFORMS
Materials:		
Welded Joints:		

Remarks: _____

_____

_____

_____

_____

_____ _____

Inspector Date

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SECTION 13390

PACKAGED CONTROL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Scope of Work
   1. Furnish, install, and place in service the packaged control systems as shown on the PLANS and as specified hereinafter.
   2. The subsequent document entitled “Appendix A – Packaged System PLCs Programming Criteria” is hereto made part of this section and includes OWNER’S requirements associated with the programming of the packaged control system PLC(s) and other project requirements. Coordinate with the OWNER’S and comply with the OWNER’S latest programming requirements. The contents of “Appendix A” are not inclusive of all requirements of this Contract. Refer to the PLANS and other Sections of the Specifications for additional information
   3. The subsequent document entitled “Appendix B – AW Host Pack Spreadsheets” is hereto made part of this section and includes OWNER’S requirements associated with the AW Host Pack spreadsheets. Coordinate with the OWNER and comply with the OWNER’S latest Host Pack spreadsheet requirements. The contents of “Appendix B” are not inclusive of all requirements of this Contract. Refer to the PLANS and other Sections of the Specifications for additional information.
   4. The subsequent document entitled “Appendix C – AW Software Tagging Criteria” is hereto made part of this section and includes OWNER’S requirements associated with the software tagging within PLC/OIU programs. Coordinate with the OWNER and comply with the OWNER’S latest tagging criteria requirements. The contents of “Appendix C” are not inclusive of all requirements of this Contract Refer to the PLANS and other Sections of the Specifications for additional information.

1.02 RELATED WORK

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 QUALIFICATIONS

A. Panels associated with the Packaged Control System (PCS) shall be designed, constructed, and tested in accordance with the latest applicable requirements of ISA, NEMA, ANSI, UL, and NEC standards. Panels shall be designed, constructed, and tested by a UL508 certified entity.

B. Assemble panels in equipment manufacturer's factories. Test panels for proper operation prior to shipment from the manufacturer's factory.

1.04 DELIVERY, STORAGE AND HANDLING

A. Protection
   1. The Contractor, and hence the PCS supplier, shall be responsible for safety of the PCS during storage, transporting and handling.
   2. The PCS equipment shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
   3. At all times the PCS equipment shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   4. Interior and exterior of PCS equipment shall be kept clean at all times.
   5. Energize the space heaters within the PCS and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:
   1. Environmentally protected and stored in climate controlled (temperature, humidity, and non-corrosive class) environment at the job site. Size, furnish and install temporary gaseous air scrubbers, air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
      a. Ambient Dry Bulb Temperature:
         1) Minimum: 68 degrees Fahrenheit.
         2) Maximum: 85 degrees Fahrenheit.
      b. Ambient Relative Humidity: Maximum: 50%.
      c. Ambient Corrosion Level: International Society of Automation Class: G1
   2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
   3. Upon arrival of equipment onto job site, the Contractor shall provide proper transition of power to equipment, especially any 120 VAC powered equipment, to ensure all air conditioning, heating, and gaseous air scrubbing equipment are fully operational and that the equipment is in a conditioned space on the day the equipment arrives.
   4. Furnish and install replacement air scrubber media, air filters, etc., as required for proper operation of the environmental control equipment.

1.05 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:
   1. Dimensioned/scaled top and bottom enclosure views, front enclosure elevations, and internal component/device layouts
   2. One-line diagrams and wiring diagrams, as applicable,
   3. Catalog cut sheets. Include protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable. Include color chart for control panel color selection by the OWNER.
   4. Additional information as described in Appendix A – Packaged System PLCs Programming Criteria.

B. Where Programmable Logic Controllers (PLCs) are provided as part of the PCS (refer to Section 2.03, this Section of the Specifications), submit PLC programming documentation in accordance with the requirements of Section 01300 of the Contract Specifications. Include:
   1. PLC program input/output point listing, including all PLC software input/output points obtained through all serial communication interfaces. Include points obtained from the OWNER's Distributed Control System that are necessary for proper operation of the PCS. Multiple submittals of this listing will be required to facilitate the PLC programming coordination specified herein. The input/output point listing shall be provided electronically in Microsoft Excel format. The input/output point listing shall be submitted along with the product data. Submittals excluding the input/output point listing shall not be accepted. At minimum, the following shall be identified in the input/output point listing for each input/output point:
      a. Register Address: The PLC register address associated with the point
      b. Tag Name: the tag name as assigned in the PLC program for the data point
      c. Description: the description of the data point
      d. Data Type: the data type as used in the PLC program (integer, floating point, etc.)
      e. Origin. For those points transmitted via a serial communication network, the PLC identifier and its associated register address
      f. Terminal block locations.
      g. Additional supplementary information as recommended by the packaged control system manufacturer to enhance the understanding of the i/o listing.
   2. Submit a Plant Control System interface table in electronic Microsoft Excel file format. The Plant Control System interface table is to consist of only those data points in the packaged system vendor's PLC data registers that are to be shared with the OWNER'S Top-End computer system and/or PLC system via the Modbus/TCP communication with the packaged control system PLC. This plant control system interface table should consist of ONLY points that are intended to be shared with the plant control system (Plant PLC's and plant SCADA computers). These data points should include, in particular, equipment status (e.g., on/off), process values (e.g., pressure, level, flow, etc.), equipment mode (e.g. manual/auto or lead/lag), alarms, data points associated with the protective relays/power monitoring units and telemetered through the Modbus/TCP communication data link connected to the PCS (minimum points

as described hereinafter), and additional data points that are available to or can be developed by the PCS as requested by the Owner. The table should also include control commands and setpoints (if appropriate and as deemed fit by the vendor). No other data points, e.g. internal/temporary registers, should be listed in this table. The quantity and type of input/output points to be made available to the OWNER'S Distributed Control System through the serial communication interfaces will be determined after Bid Award. Provide the input/output points as requested by the OWNER at No Additional Charge to the OWNER. The Plant Control System interface table is to consist of the following columns:

a. Register Address: The PLC register address associated with the point
b. Tag Name: the tag name as assigned in the PLC program for the data point
c. Description: the description of the data point
d. Data Type: the data type as used in the PLC program (integer, floating point, etc.)
e. EGU Min: Minimum value for data point (for non-Boolean values). It is assumed the point is scaled to the engineering units (EGU) value in the vendor PLC for use by the plant control system
f. EGU Max: Maximum value for the data point (for non-Boolean values). It is assumed the point is scaled to the engineering units (EGU) value in the vendor PLC for use by the plant control system.
g. EGU: engineering units used (for non-Boolean values).
h. Bool 0 Desc: The description of the Boolean point when it is Boolean 0
i. Bool 1 Desc: The description of the Boolean point when it is Boolean 1
j. Alarm Priority: The alarm priority (for alarm points only) is to be one of H, M, or L, where H = High priority alarm, M = Medium priority alarm, L = Low priority alarm
k. Direction: The direction is to be one of R, W, or RW, where: R = Data is read by the plant control system from the vendor PLC , W = Data is written by the plant control system to the vendor PLC, RW = Data is read and written by the plant control system from/to the vendor PLC
l. Discrete Commands from plant HMI to PLC: If any discrete command bits are required from the plant HMI control system to the PLC, then the PLC will reset the command bit to zero at the end of each PLC scan. The command is to take action in the vendor PLC on Boolean 1, and have no action in the vendor PLC on Boolean 0.
m. All alarms shall be Boolean such that 0 is the normal condition and 1 is the alarming condition
n. Heartbeat Register in each PLC: For each PLC, please provide a heartbeat register that increments once every 0.1 seconds, is of Type INT and has a range of 0 to 32767
o. Boolean Status Points: Map all 0x (%M) register Boolean points to 4x registers (%MW) words of WORD data type and provide indexing into the 4x register to attain the Boolean value. All equipment on/off statuses shall be Boolean such that 0 = OFF, 1 = ON

3. Completed AW Host Pack spreadsheets. The OWNER will furnish Host Pack spreadsheets electronically in Microsoft Excel format. Include effort to coordinate with the OWNER related with the Host Pack spreadsheets and submit the completed Host Pack spreadsheets in electronic Microsoft Excel file format. The formatting of the Host Pack spreadsheets may not be altered

without prior approval from the OWNER. Refer to Appendix B – AW Host Pack Spreadsheets for additional requirements for bidding purposes.

4. Minimum data points to be telemetered by the PCS for protective relays/power monitoring units that are connected to the PCS are as follows: Voltage (average, A-B,B-C,C-A), Current (average, A, B, C, Ground), power factor, horsepower, kw, kvar, kva, mwh, and all alarms and trip conditions that are configured on the protective relay/power monitoring unit.
5. Minimum data points to be telemetered by the PCS for PLC diagnostics include: scan time of the PLC program as an integer value in milliseconds, Boolean variable of a diagnostic alarm for each used slot of each PLC rack, overall diagnostic bit for each rack (if any slot in the rack is in alarm), and an overall diagnostic bit for the whole PLC system (if any rack is in alarm), where for each diagnostic bit 0=normal, 1=alarm. PCS shall configure each analog card point so that unused points are unchecked in their configuration, avoiding nuisance diagnostic alarms for analog cards.
6. PCS shall set the PLC clock of each PLC and provide integer variables for hour, minute, second, month, day and year. The PCS shall configure the PLC for automatic daylight savings and set to the central time zone. The PCS shall provide variables for clock READ, representing a read-only indication of the PLC date and time, and another separate set of variables for clock WRITE, representing variables used to set the PLC clock. The PCS shall provide a Boolean “clock set” command bit such that the Owner’s control system can write to the clock WRITE variables and will set the PLC’s clock on transition of the “clock set” command bit from 0 to 1.
7. Electronic files of PLC program in editable electronic files and PDF on CD-ROM. Follow the file format as described hereinafter.
8. Electronic files of the OIU screens in editable electronic files (Schneider Electric Vijeo *.vdz file format) and PDF on CD-ROM. Follow the file format as described hereinafter.
9. Additional information as described in Appendix A – Packaged System PLCs Programming Criteria.

C. Sequence of operation. In addition to the operation of the PCS, include the OWNER’s process/mechanical equipment that shall also be monitored/controlled by the PCS, where applicable.

D. Testing Related Submittals:
   1. Submit ORT test procedures and test results per Section 17100.
   2. Submit PAT test procedures and test results per Section 17100.

E. Certified Report: Submit a report prepared by PCS Manufacturer’s technical representative certifying satisfactory installation, operation, and in service placement of entire PCS.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:
   1. Installation and operation manuals
   2. Renewal parts bulletin
   3. As built drawings, including approved shop drawings

4. Test data
5. Software program hardcopy (as applicable) for final as-built software
6. Additional information as described in Appendix A – Packaged System PLCs Programming Criteria

1.07 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each PCS in conformance with the specifications, and complete with all accessories as identified in the specifications:
   1. One (1) – Set of fuses (minimum 3) for each type and size used for fuses 110V and greater.
   2. One (1) – Set of starter contacts for every three (3) like starters used (a minimum of 1 for each size used). If contacts are not replaceable a spare starter for each size used shall be supplied.
   3. One (1) - Contactor coil for every NEMA size and type starter installed; a minimum of one coil per size.
   4. One (1) - Spare control relay, complete with all accessories, for each relay type used.
   5. One (1) - Spare timing relay.
   6. One (1) – Sets of overload heaters for each size and type used.
   7. One (1) – Selector switch, complete with 2 auxiliary contacts, of each type used (two position, three position, etc.).
   8. One (1) – Pilot light, complete with auxiliary contact, of each type used.
   9. One (1) - Push button, complete with auxiliary contact, of each type used.
   10. Ten percent - terminal blocks, of each type and color used.
   11. Ten percent – PLC input/output modules, with minimum of one of each module type used.
   12. Ten percent – PLC CPU and Ethernet networking modules, with minimum of one of each module type used.
   13. Ten percent – PLC power supply, with minimum of one for each type PLC used.
   14. Ten percent – PLC CPU memory cards, with minimum of one of each type used.
   15. Ten percent – Ethernet switches, minimum of one of each type used.
   16. Ten percent – OIU, with minimum of one of each type used.
   17. One (1) spare PLC rack of each type used.
   18. PLC rack extender module, terminator, and cabling: Ten Percent (minimum of 2) of the number required for each type of PLC used.
   19. One (1) spare power supply of each type of power supply (24VDC, etc.) used.
   20. One (1) spare media converter of each type used.
   21. One (1) spare fiber patch panel of each type used.
   22. One (1) spare Ethernet Copper patch panel of each type used.

1.08 SPECIAL MANUFACTURER SERVICES

A. Where PLCs are provided as part of the PCS (refer to Section 2.03, this Section of the Specifications):
   1. The PCS Manufacturer shall include, at minimum, four (4) meetings dedicated for the purpose of coordinating PLC programming and OIU screen development. The meetings shall be conducted to assist in the coordination

effort needed to interface the PCS with the OWNER's Distributed Control System, inclusive of all the OWNER's PLCs and Top-End (host) computer system, and coordination of PCS PLC algorithm development and OIU screens where required to achieve the overall functional requirements of this Specification. The PCS Manufacturer shall provide a non-sales type representative to attend each meeting who is also intimately familiar with the PLC programming of the PCS. For bidding purposes, each meeting shall have a two (2) hour duration and can be held at the OWNER'S project site. At each meeting, the PCS Manufacturer shall also provide a submittal of the PLC program input/output point listing, sequence of operation, and electronic files of the PCS PLC program developed to date. Refer to the Submittals section of this Specification for minimum composition of input/output point listing, sequence of operation, and electronic PLC program files. The PCS Manufacturer shall include all necessary travel, submittal reproduction, and miscellaneous other expenses associated with their meeting attendance.

2. PLC software registers associated with the input/output point types (i.e., discrete input, discrete output, analog input, analog output) that are telemetered to the OWNER's distributed control system shall be organized contiguously among each input/output point type.
3. In the software programming, adhere to the software tagging as described in "Appendix C – AW Software Tagging Criteria" to the extent practicable. Coordinate software tagging with the OWNER.

B. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to advise the Contractor in the installation of the equipment and assist in all PCS testing and start-up. Include checking alignment of parts, wiring connections, operation of all panels, parts (relays, starters, PLCs, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the OWNER with a report certifying that the equipment was installed, properly tested, and set in accordance with the PCS manufacturer's requirements and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

C. Any problems encountered with the operation of equipment, parts, components, etc. installed within the PCS shall be repaired/remedied by the manufacturer's technical representative.

D. Prepare an arc-flash study, harmonic study, and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services.

1. The characteristics of the main PCS protective device that are most suitable for the system in providing proper protection and coordination (i.e., symmetrical short circuit rating, current limiting, electronic trip, etc.) shall be determined per Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.
2. The Manufacturer shall select, set, and adjust the load side devices served by the main PCS protective device accordingly at No Additional Cost to the

OWNER. Manufacturer's technical representative is to set, adjust and test all circuit breakers, relays, motor circuit protectors, etc. in the presence of a representative of the OWNER.

3. Provide the OWNER with a test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and 01730 of the Contract Specifications.

PART 2 PRODUCTS

2.01 GENERAL

A. Furnish and install all necessary components and wiring for a complete and functional system. Furnish and install additional requirements as follows:
   1. Furnish and install the enclosure as hereinafter specified. Mount and wire all components inside of enclosure unless specified otherwise. The enclosure, with all components mounted and wired, complete with all accessories, shall be referred to hereinafter as the Control Panel.
   2. Furnish and install the Control Panel configured for single point electrical feed that terminates on a dedicated main circuit breaker inside of the Control Panel. Refer to the PLANS and also the appropriate Division 11 Specification for which the PCS is provided for voltage and phase requirements. The Control Panel shall contain all necessary means, i.e. , control power transformer with primary and secondary short circuit protection/disconnects, uninterruptible power supply, associated wiring, short circuit protection, etc. to derive and distribute the needed control power at the necessary voltages for the entire PCS.
   3. Furnish and install the control system Type as hereinafter specified.
   4. Furnish and install motor starters/drives as specified herein, by other Sections of the Specifications, and the PLANS. Size, furnish, and install motor starters/drives complete with all accessories as specified.
   5. Furnish and install circuit breakers for branch circuits distributed from Control Panel as hereinafter specified. Coordinate operation of branch circuit breakers with corresponding main circuit breaker for proper circuit isolation and protection. Note, the main circuit breaker for the control panel per paragraph 2.01.A.2 shall not be considered a branch circuit breaker for the purposes of this Specification.
   6. Furnish and install field devices that are fully corrosion resistant, water tight, and resistant to all chemicals associated with the process application. All field devices life cycle, operation, and accuracy shall not be affected by the process application. As a minimum, all field devices shall be U. L. Listed and NEMA 4X rated. The mounting arrangement shall include provisions to enhance operation and maintenance of the system in consideration of the process application.
   7. Where devices are required for the functional operation of the PCS but are not specified under Division 17, furnish and install manufacturer’s standard.
   8. Where process taps/connections are located higher than 5 feet above finished floor/grade, furnish and install remote mounted indicating transmitters and extend tubing as required to facilitate mounting transmitters no higher than 5 feet above finished floor/grade.

9. For additional construction notes and special requirements, refer to the PLANS and the Specifications.

B. Analog, Control, and Alarm Signaling Requirements
   1. Refer to the PLANS and also the appropriate Division 11 Specification for which the PCS is provided for minimum contacts to be connected to the OWNER's Distributed Control System.
   2. All control and alarm circuits shall be 120 volts A.C. Alarm signal contacts shall open to alarm and shall be isolated contacts rated for 5 ampere at 120 volts A.C.
   3. The contact configuration (normally open/closed) required for proper interface to the OWNER's Distributed Control System shall be furnished and installed at No Additional Cost to the OWNER. Under no circumstances shall contacts of pushbuttons and selector switches be connected to the OWNER's Distributed Control System via interposing relays. Refer to Section 17600 for minimum interface requirements to the OWNER's Distributed Control System.
   4. All analog signals shall be 4 to 20 mA DC. Use "two-wire" type circuits where possible. Furnish and install loop current isolators for each analog signal circuit in which either the field device or Control Panel is located outdoors. Loop current isolators shall be per Section 17200.
   5. All RTD signals shall be 100 ohm platinum type.

C. Selector Switches, Pilot Devices, Pushbuttons requirements:
   1. For NEMA 12 rated enclosures: Furnish and install per Section 17200.
   2. For NEMA 4X rated enclosures: Furnish and install per Section 16540.
   3. Mount on enclosure door.

D. Wiring: Furnish and install as specified in Section 17200 and 17600. Group conductors and route in wireways as specified in Section 17200. Wire insulation pigmentation for 480 VAC circuits shall be per Section 16200. Field wiring shall be per Section 16200.

E. Identification: Tag enclosure, terminal blocks, and devices (mounted interior and on the face of the enclosure) as specified in Section 17200. Tag all wiring per the requirements of Section 16205.

F. Grounding: Furnish and install grounding per Section 17200.

G. Miscellaneous Accessories:
   1. Furnish and install lugs/ power distribution blocks /terminal blocks as required for the connection of the field wiring. Furnish and install terminal blocks per Section 17200. Furnish and install the necessary means for the termination of the field wiring at No Additional Cost to the OWNER.
   2. Furnish and install a Type 2 surge protective device for the 120 VAC package control system control power circuitry. Wire, and mount inside the enclosure.
   3. Furnish and install 24 volts DC power supply and all other power supplies per the PCS manufacturer's requirements where not specified per Section 17200. Wire and mount inside the enclosure.
   4. Where an uninterruptible power supply is needed for the application, furnish and install per Section 17200. Packaged control systems having PLCs shall also be furnished with uninterruptible power supplies per Section 17200.

5. Arrange the enclosure internal components to coordinate with the OWNER's conduit entry requirements at No Additional Cost to the OWNER.
6. Where junction/pull boxes are required, furnish and install per Section 16130.

H. All outdoor located enclosures and field indicators/transmitters shall also have a sunshield hood per Section 17380 and as detailed on the PLANS, with the following exceptions:
1. PCS manufacturer to adjust the sunshield dimensions as necessary to coordinate with the dimensions of the control panel/instrument.
2. The hinged flap detailed on the PLANS is not required for control panels.
3. Orient as described on the PLANS and coordinated with the Owner.

2.02 CONTROL PANEL ENCLOSURE REQUIREMENTS

A. Enclosure shall be the totally enclosed, dead front, suitable for back-to-wall mounting. Free standing and wall mounted enclosures may be used. Enclosure shall be adequately sized to contain all of devices required for the PCS in addition to facilitating the termination and routing of all associated PCS field interconnect conduit/wire systems.

B. Unless specifically noted otherwise elsewhere, enclosures shall be rated:
1. Enclosures located outdoors: NEMA Type 4X, Type 316 Stainless Steel enclosures.
2. Enclosures located indoors in process/mechanical areas and storage areas that are not environmentally and climate controlled: NEMA Type 4X, Type 316 Stainless Steel enclosures.
3. Enclosures located indoors in areas that are environmentally and climate controlled: NEMA 12-gasketed, painted steel enclosures per Section 17200.

C. Enclosure shall have hinged, gasketed doors. Each door shall have an operating handle. At minimum, Furnish and install quarter turn door latch. Furnish and install three point door latch where available for the enclosure. Furnish and install pad locking means for the door/handle.

D. Enclosures shall have a door mounted variable depth disconnect operating mechanism for operating the main circuit breaker and providing access to the 480V compartment. Provide padlockable disconnect operating handle. Handle shall be mechanically interlocked with the door/barrier to prevent personnel from opening the door and accessing the 480V compartment when the unit disconnect is in the ON position. Furnish and install handle-door interlock defeating (bypass) feature. Disconnect operating mechanism shall be as manufactured by Square D Class 9421 or approved equal. Electric actuated door interlock means will not be accepted.

E. When sizing the enclosure, consideration shall be given to the enclosure installation location and the environmental aspects associated with the location (indoors, outdoors, etc.). Enclosures shall be sized to adequately dissipate heat generated by the equipment contained therein. Enclosures shall be provided with the necessary climate control devices, i.e. air conditioners, cooling fans, thermostatically controlled heaters, as required, for proper PCS operation. All

outdoor located enclosures containing PLCs shall have air conditioners as hereinafter specified.

F. Furnish and install enclosure manufacturer's factory interior backpanels and sidepanels as required to facilitate interior device mounting. Panels shall be factory painted white.

G. For all PCS enclosures containing components rated greater than 120 VAC and components rated 120 VAC and less, the enclosure shall consist of two compartments. Each compartment shall have an independently operating door. A barrier shall extend the full height and depth of the enclosure to separate the two compartments and isolate power and control components rated 120 VAC and less from all components rated greater than 120 VAC.

H. The following are required for all outdoor enclosures containing PLCs and for indoor enclosures containing PLCs that are located in Process/Mechanical areas and Storage areas that are not environmentally and climate controlled:
   1. Air Conditioner:
      a. Sizing and Quantity: Provide the size and quantity of units as required for the application environment.
      b. Type: Thermostatically controlled packaged closed-loop air conditioner climate control unit surface mounted to the exterior side of the control panel. Suitable for use in an outdoor corrosive environment and also rated Class 1 Division II.
      c. Material: NEMA 4X, Type 316 Stainless Steel enclosure suitable and rated for use in corrosive environment, 16-gauge minimum thickness. Internal components shall be coated for corrosion protection.
      d. Electrical Service: Connect to the PCS single point electrical service via a dedicated circuit breaker.
      e. Controls:
         1) Provide air conditioner manufacturer's standard air conditioning system package control system for the air conditioner. The air conditioner shall have the capability to be controlled by the industrial thermostat specified hereinafter.
         2) Each air conditioner shall include low ambient controls to allow the unit to operate down to 0 degrees Fahrenheit ambient conditions.
         3) Provide a dedicated thermostat for each air conditioner. The thermostat shall be per Section 17200. The thermostat for each air conditioner unit shall be mounted inside the cabinet.
      f. Accessories:
         1) Condensate Management System: Each air conditioner unit shall have a condensate management system that evaporates moisture from the enclosure into the condenser air stream and shall not require disposal of liquid condensate and shall not cause build-up or spillage of liquid condensate.
         2) Air filters: Field replaceable aluminum filters.
         3) Extension frame with self-contained Drip Pan Tray
         4) Mounting gaskets and hardware for a complete installation
         5) Reinforce the cabinet enclosure as required to support the air conditioner.

g. Manufacturer: EIC Solutions, Inc., Thermal Edge, Inc. or Engineer approved equal.

2. Cabinet Interior Insulation:
   a. General:
      1) Provide insulation for interior of cabinet to the extent practicable to reduce heat transfer.
      2) Install in accordance to manufacturer requirements, minimize the number of duct board sections and provide no gaps between sections
      3) Install with cleanable aluminum foil (FRK) facing on exposed surface such that no bare fiberglass surface is exposed or visible. Install panels and other equipment onto cabinet such that insulation is not compressed.
      4) Securely fasten duct board onto cabinet interior surface with adhesive with 100 percent coverage of adhesive at board fiber side contact with cabinet inner surface area.
      5) Where heat dissipating device or other device is mounted onto cabinet panel, provide a 1-inch gap between duct board and device or as required to allow proper operation of device per device manufacturer requirements.
      6) Neatly cut duct board to provide a clean finished appearance.
   b. Material: 1-inch thick fiberglass duct board having a rigid resin bonded and flame retardant fibrous glass board with a damage-resistant reinforced aluminum foil (FRK) facing
   c. Thermal Conductivity: (K at 75 degrees Fahrenheit) no greater that 0.23 BTU-inch per hour foot-squared degree Fahrenheit.
   d. Adhesive, tape, and duct board installation shall comply with NFPA 90A or NFPA 90B and UL 181A and ASTM C 916.
   e. Manufacturer: Owens Corning series QuietR or approved equal
   f. Accessories:
      1) Tape: Aluminum foil / scrim / kraft (FSK) 3-inch minimum width non-tearable with diamond patterned backing, a rubber based adhesive system, and shall meet requirements of UL 723 and as manufactured by Shuretape or approved equal.

3. Space Heater:
   a. Sizing and Quantity: Provide the size and quantity of units as required for the application environment.
   b. Type: Thermostatically controlled. Provide a dedicated thermostat for the space heater. The thermostat shall be per Section 17200. The thermostat shall be mounted inside the enclosure.

4. Interior Enclosure Ambient Air Temperature Transmitter: Furnish and install a temperature transmitter to monitor the interior cabinet ambient air temperature. Transmitter shall be per Section 17380. Although not shown on the PLANS, connect the 4-20mADC analog output from the transmitter to the packaged control system PLC for remote monitoring by the OWNER'S Distributed Control System. The internal cabinet ambient air temperature shall be visible exterior of the cabinet, regardless if the temperature value is displayed on any OIU screen. Furnish and install a discrete digital indicator as required to display the internal cabinet ambient air temperature.

I. Furnish and install the following additional accessories for each enclosure:
   1. For each door:
      a. Grounding bonding jumper.
      b. Door stop kit.
      c. 12-inch door data pocket.
   2. For free standing enclosures:
      a. Furnish and install light fixture per the requirements of Section 17200.
      b. Furnish and install wire convenience receptacle per the requirements of Section 17200.
      c. Furnish and install lifting eyes.
   3. Furnish and install all additional enclosure accessories, mounting hardware, 19 inch rack accessories, etc., as required for a functional PCS.
   4. Additional requirements for indoor enclosures located in areas that are environmentally and climate controlled: Furnish and install enclosure complete with all accessories per Section 17200.

J. Enclosures shall be as manufactured by:
   1. All outdoor enclosures and indoor enclosures located inside process/mechanical areas and storage areas that are not environmentally and climate controlled:
      a. Wall mounted control panel: Hoffman Concept Stainless Steel 4X Wall Mounted Enclosure Series with CWHPTO Padlock Handle, or approved equal.
      b. Free Standing control panel: Hoffman Free-Standing Single and Dual Access with 3-Point Latches and Lockable Powerglide® Handles, Type 4X Enclosures, or approved equal.
   2. Indoor enclosures located inside environmentally and climate controlled areas: Furnish and install per the requirements of Section 17200.

2.03 PACKAGED CONTROL SYSTEM TYPES

A. The PCS shall use one of two types of control system types to implement the packaged control system functionality as follows:
   1. Type A: At minimum, this type shall employ the use of PLCs as described hereinafter. PLCs in combination with hardwired relay logic may be used at the PCS Manufacturer's discretion.
   2. Type B: This type shall only employ the use of hardwired relay logic. This control system type shall not include the use of PLCs whatsoever. Additionally, any type of micro-processor based programmable relay, any relay requiring software download, or any other type of similar programmable relay shall not be used. As technology advances over time, similar appearing devices are subject to review and approval by the OWNER after Bid Award and the PCS Manufacturer shall incorporate the OWNER's request at No Additional Cost to the OWNER.

B. Additional requirements for Type A systems only:
   1. General:
      a. The type of PLC (Type 1 or 2) as hereinafter specified shall be selected by the PCS Manufacturer to meet the functional requirements of this Specification and also the appropriate Division 11 Specification for which

the PCS is provided. Additional types of PLCs beyond those listed here shall not be accepted.

1) Type 1: Furnish and install Type 1 PLCs as specified in Section 17600.
2) Type 2: Furnish and install Type 2 PLCs as specified in Section 17600.

b. All equipment shall be furnished and installed complete with all necessary software.
c. As a minimum, the PCS shall communicate with the equipment as shown on the control system architecture, in addition to the OWNER'S Top-End computer system. Program the PCS accordingly.

2. Operator Interface Unit (OIU):
   a. Type 1: Furnish and install Type 1 OIU as specified in Section 17600
   b. If a specific type of OIU is not shown on the PLANS or Specifications, the default type shall be Type 1.
   c. Furnish and install the additional quantities of OIUs as may be required by the PLANS or Specifications.
   d. Mount OIU on enclosure door, providing additional enclosure accessories (window kit, etc.) as needed to achieve appropriate NEMA rating.
   e. Furnish and install a sun shield as specified in Section 17380 for all OIUs installed on enclosures located outdoors.
3. Miscellaneous:
   a. Furnish and install the Ethernet switches, patch panels, and related hardware/accessories as specified in Section 17600 and as shown on the PLANS to facilitate the network data connections of the PCS to the OWNER's Distributed Control System.
   b. Although not shown on the PLANS, furnish and install one 120Vac, 1P-20A GFI convenience receptacle and 1 Cat 5e Ethernet data port receptacle with NEMA 4X rated hinged UV resistant clear polycarbonate cover. Receptacles shall be accessible from control panel exterior without requiring access to internal control panel components. Wire receptacles to Ethernet switch and control power supply of internal control panel. Furnish and install receptacles as manufactured by Hubbell "Panel-Safe", model PR4X205E or approved equal.
   c. Furnish and install additional 25 percent excess capacity over the number of inputs, outputs, and other necessary functions.

C. Requirements common to Types A and B systems:
   1. Refer to the PLANS and also the appropriate Division 11 Specification for which the PCS is provided for the control system type.
   2. Furnish and install control relays and timing relays as specified in Section 17200.

2.04 MAIN AND BRANCH FEEDER CIRCUIT BREAKERS

A. Furnish and install thermal magnetic molded case circuit breakers. Size per NEC. Circuit breakers shall have U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the bus serving the equipment, unless noted otherwise on the PLANS or in the Division 11 Specifications. Unless shown otherwise, the minimum RMS symmetrical short circuit current rating shall be 42kA at 480 volts A.C.

B. Furnish and install where specifically shown on the PLANS or for proper circuit protection/coordination:
   1. Current limiting circuit breaker.
   2. Electronic trip attachment. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings.

2.05 MOTOR STARTERS AND VARIABLE FREQUENCY DRIVES

A. Furnish and install per the requirements of Section 16120 Subsection 2.04 "Combination Units" with the following exceptions:
   1. General:
      a. Comply with the control logic requirements of the PCS manufacturer.
   2. Circuit breakers:
      a. Shall have U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the bus serving the equipment, unless noted otherwise on the PLANS or in the Division 11 Specifications. Unless shown otherwise, the minimum RMS symmetrical short circuit current rating shall be 42kA at 480 volts A.C.
   3. Starters:
      a. Size and configuration (full voltage non-reversing, full voltage reversing, etc.) as required for the application. Size per NEC and provide minimum of NEMA Size 1.
   4. Control Power Transformer:
      a. Dedicated control power transformer for each motor starter is not required. Serve starter control power from PCS control power distribution per the manufacturer's standard.
   5. Power Factor Correction Capacitors (PFCCs):
      a. Furnish and install PFCCs for all constant speed motors sized three horsepower and larger. Exception: Motorized valves and reversing/jogging process applications do not require power factor correction capacitors.
      b. Connect capacitors between the motor starter and the overload relay.
   6. Variable frequency drive:
      a. Drive family (Constant torque, variable torque, etc.) to be selected by the Division 11 equipment manufacturer.
      b. The VFD minimum output current shall be as determined by the Division 11 equipment manufacturer.
      c. VFDs serving motors smaller than 40 horsepower may be 6 pulse in lieu of 18 pulse, provided the harmonic performance requirements at the terminals of the packaged control system comply with the latest version of IEEE 519. Where 6 pulse VFDs are installed, furnish and install a harmonic filter dedicated to each 6 pulse VFD per Section 16483, at a minimum. Locate the harmonic filter inside of the PCS enclosure.
   7. Reduced Voltage Solid State Soft Starter (RVSS):
      a. Each solid-state reduced-voltage starter assembly shall consist of an SCR-based power section, logic board, a main input isolation contactor, and a paralleling bypass (run) contactor.
      b. Each RVSS starter shall employ the use of Silicon Controlled Rectifier (SCR) technology. The RVSS starter shall have a micro-processor based SCR controller equipped with the manufacturer's standard features for protection, operation, and data acquisition of a RVSS starting system.

c. Each RVSS shall be UL listed and shall be tested according to UL 508C.
d. A paralleling bypass (run) contactor shall be supplied with each RVSS. The paralleling bypass contactor may be integral to the SCR based power section of the RVSS unit at the manufacturer's discretion.
e. Provide thermostatically controlled cooling fan for starter.

8. Overload Relays: Overload relays shall have the following characteristics:
   a. Standard class 20, ambient compensated, unless otherwise required for proper system protection
   b. Manually reset by push-button located on front of the compartment door.
   c. Provide with auxiliary contact rated for 120 volts A.C. Contact shall satisfy the requirements of the DRAWINGS.
   d. The overload relay heaters will be selected by the PCS manufacturer after delivery of the PCS. Include all necessary delivery, packaging, and administrative costs associated with the delivery of overload heaters.

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TEST

A. Each control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop test and any other additional operational test to insure the functionality, workability and reliable operation of the equipment.

B. Size, furnish and install the overload relay heaters based on actual motor nameplate current. Set overload relay settings at maximum values permitted by the NEC 430-32.

C. Size, furnish and install the motor space heater fuses based on actual motor space heater load current.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Mount all PCS subcomponents as shown on the PLANS and as recommended by the PCS manufacturer.

B. The PCS shall NOT be allowed remote access to the Owner's supervisory control and data acquisition (SCADA) system or SCADA components.

C. All field wiring shall be tagged per the requirements of Section 16205. Secure wiring in control panel with plastic ties. Arrange wiring neatly, remove surplus wire, and install abrasion protection for wiring passing through holes or near edges of sheet metal.

D. Clean and vacuum all interior of the equipment. Touch-up and restore damaged surfaces to factory finish.

3.03 FIELD TESTING

A. After field installation of the PCS and prior to energizing any of the process/mechanical equipment controlled by the PCS:
   1. Conduct an ORT for the PCS per Section 17100. Submit test results for review and approval. Prior to conducting the ORT, meet all prerequisites associated with conducting the ORT as described in Section 17100. The OWNER may elect to witness the ORT. Coordinate with the OWNER accordingly.
   2. Conduct a PAT for the PCS per Section 17100. Submit test results for review and approval. Prior to conducting the PAT, meet all prerequisites associated with conducting the PAT as described in Section 17100. Exception: As the application software for the PCS is provided by the PCS manufacturer, the PCS manufacturer shall lead the PAT software test activity.

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 13390

APPENDIX A - PACKAGED SYSTEMS PLC PROGRAMMING CRITERIA

PART 1 PACKAGED SYSTEMS PLC PROGRAMMING CRITERIA

1.01 GENERAL

A. PLC Hardware to be used by packaged equipment Vendor shall be as specified in the contract bid specifications. As a minimum, the processor used to interface to the Owner's SCADA system shall support the Schneider Electric Unity Pro programming software.

B. Vendor shall use latest version of Schneider Electric Unity Pro programming software, unless otherwise directed by Owner.

1.02 PROGRAM ORGANIZATION AND STRUCTURE

A. The overall program shall be broken down into meaningful sections of code related to the operations of the equipment. As a minimum, include the following program sections:
   1. Communications - All registers that are being written to or being read from the Vendor's package system PLC from the Owner's SCADA equipment shall be grouped into one section of the program. Register addresses used for interfacing to Owner's SCADA system shall be placed in a contiguous block of registers to facilitate read and write operations
   2. Section Control - (if code includes variables to enable/disable sections of code).
   3. Process Control - If the process is complex and/or the section is very large, this section should be further broken down into permissive section(s), alarming section(s) and control section(s).
   4. Input/Output (I/O) Processing – This section includes data manipulation of physical inputs and outputs such as analog scaling, totalizing, etc.
   5. PLC Time Synchronization and Heartbeat – This section shows the registers that are to be used to synchronize the PLC's clock with the Owner's SCADA system and to determine whether the Vendor's PLC logic is executing (heartbeat) to be monitored by the Owner's SCADA system.

B. Vendor is to follow the Owner's software tagging convention for all tags being read from or written into by the Owner's SCADA system. If the Vendor elects to use their own software tagging convention in their programs that control the equipment within their own package system, then the PLC(s) that is used to interface with the Owner's SCADA system needs to include a set of registers that will be labeled with the Owner's software tagging convention and be "mapped" to the corresponding set of registers that are used by the Vendor's software program. The mapping of these registers is to be clearly labeled in the program and indicated on the Field I/O spreadsheet to be provided at the end of the job.

C. All program sections are to be clearly labeled with text that describes what the section of code does. As a minimum, include the key wording for each section as described above.

D. Provide comment lines within the sections of code to describe what the various parts of the section do, especially for those areas where the function is performing is not evident or is complex to follow.

E. All software tags in the program are to follow a structured naming convention and be clearly labeled with meaningful text descriptions to make it easy to understand what the tag represents and what function it is performing in the program.

F. Ensure that none of the programs developed have security controls enabled, i.e. password protection on DFB's, restrictions on uploading or editing program, etc.

1.03 PROGRAM DETAILS

A. Vendor is to use IEC programming languages supported by Unity Pro, and in general adopt the following guidelines.
   1. Use Derived Function Blocks (DFB) language as much as practical to standardize on process control functions.
   2. Use Structured Text (ST) language for Calculations and I/O Mapping routines.
   3. Use IEC Ladder Logic (LL) and Function Blocks (FB) for control logic and to include in DFB's.

B. Standardize the program sections and program elements (DFB, ST, etc.) as much as possible into modular and/or functional pieces of code for repetitive and often use sections of code to simplify the program and minimize its size.

C. Vendor is to set up a Custom Library for standard program elements like DFB's and FB's.

D. Use Topological (Unity Pro) Addressing on M340 PLCs for registers associated with physical I/O, i.e. %I1.3.2 and %Q1.4.3, instead of State Ram addressing (%M) since State Ram addressing convention does not reference the physical I/O location, but topological addressing does.

E. Use eBool variables if there may be a reason to keep track of previous values (history) or there is a need to look at a leading or falling edge in the signal.

F. Avoid using IEC BMDI function blocks on any of the PLC programs since Unity Pro is not able to search for registers contained within the range of that block.

G. Use IO Scanner for communication between PLC's where possible to facilitate the set-up and troubleshooting of registers that are being moved from one PLC to another.

H. Code should be designed to avoid using force bits for the logic to execute properly. Inadvertent un-forcing of bits will cause the program to behave unexpectedly.

I. Do not initialize %MW values during a cold start or a program download. Doing so can cause stored values such as run time to be over written. Ensure this option is unchecked in the programming software if the option is available.

1.04 DOCUMENTATION AND DELIVERABLES

A. As part of their Operations and Maintenance Manual, Vendor is to include, but not be limited to the following:
   1. Control Narratives that include:
      a. The various control modes of operation; i.e. remote automatic, remote manual, local automatic, local manual, maintenance mode, etc.
      b. Identification of and description of all permissive and shutdown signals that are required to operate the equipment or that will shut the equipment down.
      c. Identification of all set points and process variables that are Operator adjustable with a description of what they do and how they affect the operation of the equipment.
   2. Field I/O and Host Pack and Peer to Peer spreadsheets (example provided by Owner) to document the various software tags associated with the package equipment.
   3. Instrument Index spreadsheet showing all instrumentation on their package equipment and calibration information including, but not limited to; instrument tag name, input range, units, control loop description, scaling, trip set points, etc.

B. Vendor is to provide a copy of all program files installed in the production system and source files of all documentation listed above.

END OF APPENDIX A

SECTION 13390

APPENDIX B – AW HOST PACK SPREADSHEETS

PART 1 AW HOST PACK SPREADSHEETS

1.01 FIELD I/O LIST DESCRIPTIONS NOTES

A. General
   1. The Field Input/Output (I/O) lists only inputs or output connected to process control equipment and devices, i.e. instrument, electrical equipment, etc.. It does not include logical inputs or outputs that are generated as part of the PLC/RTU program to do data manipulation, or data that is passed on to another controller or Host computer.
   2. All inputs and outputs associated with a PLC/RTU, i.e. physical and logical points, are shown on the Host Pack list if they are being transmitted/received by a Host computer, or are shown in the Peer to Peer Data Communications List, if the values are being shared with another peer device.

B. Information required for each entry.
   1. RACK NAME - The rack name as shown on the contract drawings. Note this name is for cross-reference only. The actual drop, and rack number used in the software configuration will be as specified in the DROP, and RACK column of the Field I/O List.
   2. FIELD DEVICE TAG - The name of the end device, in accordance with the INFOR (maintenance management system) naming convention and tagged in the field and/or on the contract drawings. This field is used as a cross-reference to the Host Pack table.
   3. DESCRIPTION - The description of the signal. This description shall be used consistently throughout the application software.
   4. CARD/MODULE TYPE - The Modicon model number located in the corresponding slot.
   5. POINT TYPE - The point type indicates AI, AO, DI, or DO for analog input, analog output, discrete input, or discrete output, respectively.
   6. DROP, RACK/BASE – The drop and rack number associated with the chassis. These fields define the required drop, rack assignment for the configuration of each chassis associated with the processor.
   7. SLOT - This field defines the physical location of the module within a given chassis.
   8. I/O POINT – This field defines the specific point on the module.
   9. CARD/MODULE TERMINALS – Physical wiring termination points on the I/O card/module.
   10. FIELD I/O ADDR. - The software register address where the I/O module places the data for the point. This field is used as a cross-reference to the Host Pack table.

11. BIT NO. - The bit within the register address where the I/O module places the data for the point, as required. This field is used as a cross-reference to the Host Pack table.
12. EGU LOW - The value of the signal at 4 mA in the specified engineering units. This information is only applicable to analog signals.
13. EGU HIGH - The value of the signal at 20 mA in the specified engineering units. This information is only applicable to analog signals.
14. EGU - The engineering units for the analog signal. This information is only applicable to analog signals.
15. SCALED IN PLC? – Defines whether or not the analog value is scaled in the PLC, or if scaling occurs at the top end. This information is only applicable to analog signals.
16. RAW LOW - The value of the signal at 4 mA in counts as written to the PLC register by the I/O module. This information is only applicable to analog signals.
17. RAW HIGH - The value of the signal at 20 mA in counts as written to the PLC register by the I/O module. This information is only applicable to analog signals.
18. SIGNAL TYPE – Electrical characteristics of the signal, i.e. 4-20 mA, 1-5 VDC, etc.
19. TERMINAL BLOCK - The name of the block of terminals where field wiring is terminated.
20. TERMINAL NO'S - The terminal numbers within the terminal block where the field wiring is terminated.
21. LOOP DIAG. – The number of the drawing where a loop drawing is shown for the signal loop. These could either be loop-specific drawings, or typical loop drawings.
22. P&ID No. – The number of the P&ID drawing where the I/O point is shown on the drawings.
23. NOTES - Miscellaneous notes to further describe the signal. This field contains information such as square root (SQRT) for analog inputs, analog alarm setpoints, shelf states for discrete inputs, etc.

1.02 HOST PACK FIELD DESCRIPTIONS NOTES

A. General Information
   1. Physical Inputs and Outputs (I/O) refer to connections to instruments and/or device/equipment including: motor status contacts, valve position switches, pump start/stop commands, etc.
   2. There are two different tagging standards for physical I/O points, depending on whether they are instruments or signals coming from or going to equipment/devices other than instruments.
   3. Instrument tags follow the ISA standards and are somewhat different from the other physical I/O points, i.e. equipment and devices, in that those tags include not only an equipment code, like the instruments, but it also includes a Function Descriptor Code that is up to four characters long. Since a piece of equipment/device may have multiple I/O points connected to it (such as a

motor starter) the Function Descriptor Code ensures uniqueness and clarifies the function performed by the specific I/O.

4. Software TagNames assigned to a PLC/RTU program are identical to the physical I/O points, i.e. Instrument Tags and Equipment/Device Tags.
5. Software TagNames that are generated by a controller or a host computer that are not tied directly to a physical I/O point, follow the same convention as the equipment and instrument tags, except a suffix is added to the end of the physical tag to indicate the origination/destination of that software tag, i.e. whether the point is logically created in the PLC/RTU or Host program and were it is sending its information to.

B. Information required for each entry.
   1. Host SCADA Configuration Information – the fields in this section relate to configuration of alarming and general point information for use in the SCADA Host database.
      a. HOST NODE NAME(S) - The computer name of PMCS SCADA Servers which will be polling the PLC, including OIUs.
      b. HOST TAGNAME - The tagname used in the PMCS host software to reference the input point.
      c. DB TYPE - The database point type used in the OIU and PMCS database definition for the point. See Table 4-3 in the System Integration Design Guide for a list of available database point types.
      d. HOST DESCRIPTION - A description of the signal. The description field is limited to 40 characters.
      e. ACTIVE STATE (1) - The definition of the energized state for a discrete point.
      f. INACTIVE STATE (0) - The definition of the de-energized state for a discrete point.
      g. ALARM STATE – Defines if either the Active or Inactive states will be used to generate an alarm a discrete point.
      h. LOLO ALARM - The setpoint for the low low alarm limit for an analog point.
      i. LO ALARM - The setpoint for the low alarm limit for an analog point.
      j. HI ALARM - The setpoint for the high alarm limit for an analog point.
      k. HIHI ALARM - The setpoint for the high high alarm limit for an analog point.
      l. ALARM PRIORITY - The alarm priority. The alarm priority shall be defined as L, M, or H for low priority alarm, medium priority alarm, or high priority alarm, respectively. If the point does not require alarming, then this field shall be blank for the point. If multiple analog alarm setpoints are defined, alarm priorities shall be indicated for each alarm type.
   2. PLC Host Read/Write Area – the fields in this section define the interface between the host database and the PLC/RTU.
      a. HOST I/O ADDR - The register address in the PLC which the host will read to get the current value of the point.
      b. HOST BIT NO - The bit within the register address in the PLC which the host will read to get the current value of the point.

c. HOST PLC DATA TYPE - The data type of the signal in the PLC register. This defines how the PMCS interprets the data in the PLC register(s). Options for this field are based on the data types used in the PLC/RTU.
d. PLC SOFTWARE TAGNAME - The name of the register(s) that the PMCS host will read to current value of the point, as defined in the PLC/RTU software.

3. PLC Intermediate Area – the fields in this section identify any intermediate registers used in the PLC/RTU to perform calculations or process the input signals from the I/O module.
   a. INT I/O ADDR - The register address in the PLC where the intermediate data value is stored.
   b. INT BIT NO - The bit within the register address in the PLC where the intermediate data value is stored.
   c. INT DATA TYPE - The data type of the signal in the intermediate PLC register. Options for this field are based on the data types used in the PLC/RTU.
   d. PLC SOFTWARE TAGNAME - The name of the register(s) in the PLC where the intermediate data value is stored, as defined in the PLC/RTU software.
4. Field Interface Area – the fields in this section identify information about the field devices and register locations written to by the I/O modules.
   a. PEER DEVICE – Indicates whether or not the point is transmitted from anoter PLC, as opposed to being acquired from local I/O.
   b. FIELD DEVICE TAG - The name of the end device, in accordance with the INFOR (maintenance management system) naming convention and tagged in the field and/or on the contract drawings. This field is used as a cross-reference to the Field I/O List table.
   c. POINT TYPE - The point type indicates AI, AO, DI, or DO for analog input, analog output, discrete input, or discrete output, respectively.
   d. FIELD I/O ADDR. - The software register address where the I/O module places the data for the point. This field is used as a cross-reference to the Field I/O List table.
   e. FIELD BIT NO. - The bit within the register address where the I/O module places the data for the point, as required. This field is used as a cross-reference to the Field I/O List table.
5. Other fields
   a. PLC/RTU EQUIPMENT TAG - The name of the PLC or RTU device, in accordance with the INFOR (maintenance management system) naming convention and tagged in the field and/or on the contract drawings. This field is used as a cross-reference to the Field I/O List table.
   b. NOTES – Miscellaneous notes specific to the database point.

1.03 PEER TO PEER DATA COMMUNICATIONS DESCRIPTIONS NOTES

A. General
   1. The Peer to Peer Data Communications list is intended to only show data (inputs or outputs) that is shared between two peer devices such as PLC/RTU controllers. The list does not include any other physical I/O points connected to

the associated PLC/RTU or data points that are transmitted to or received from a Host computer.

2. For physical I/O points connected to a specific PLC/RTU, refer to the Field Input/Output (I/O) list.
3. For data points that are associated with a particular PLC/RTU that are transmitted to or received from a Host computer, please refer to the Host Pack list.
4. Information required for each entry.
    a. PLC SOFTWARE TAGNAME - The name of the register(s) that the PMCS host will read to current value of the point, as defined in the PLC/RTU software.
    b. DESCRIPTION - A description of the signal. The description field is limited to 40 characters.
    c. HOST PLC DATA TYPE - The data type of the signal in the PLC register. This defines how the PMCS interprets the data in the PLC register(s). Options for this field are based on the data types used in the PLC/RTU.
    d. ORIGINATION EQUIPMENT TAG - The name of the PLC or RTU device where the point data is coming from (source of the data), in accordance with the INFOR (maintenance management system) naming convention and tagged in the field and/or on the contract drawings. This field is used as a cross-reference to the Field I/O List table, Host Pack table, or other Peer to Peer tables.
    e. ORIGINATION I/O ADDR - The register address in the source PLC which the destination peer device will read to get the current value of the point. This field is used as a cross-reference to the Field I/O List table, Host Pack table, or other Peer to Peer tables.
    f. ORIG BIT NO - The bit within the register address in the source PLC which the destination peer device will read to get the current value of the point. This field is used as a cross-reference to the Field I/O List table, Host Pack table, or other Peer to Peer tables.
    g. DESTINATION EQUIPMENT TAG - The name of the PLC or RTU device where the point data is being written to (consumer of the data), in accordance with the INFOR (maintenance management system) naming convention and tagged in the field and/or on the contract drawings. This field is used as a cross-reference to the Field I/O List table, Host Pack table, or other Peer to Peer tables.
    h. DESTINATION I/O ADDR - The register address in the consumer PLC which the source peer device will write to provide the current value of the point. This field is used as a cross-reference to the Field I/O List table, Host Pack table, or other Peer to Peer tables.
    i. DEST BIT NO - The bit within the register address in the consumer PLC which the source peer device will write to provide the current value of the point. This field is used as a cross-reference to the Field I/O List table, Host Pack table, or other Peer to Peer tables.
    j. HOST INTERFACE? – Indicates whether the destination device passes the data to the PMCS host, or whether the data will be passed along to another peer device.

k. BLOCK MOVE TYPE – Indicates the function block or other method used to facilitate the transfer of peer data.
l. BLOCK MOVE DEVICE – The name of the PLC/RTU whose program includes the block move command. The Origination device can write the data to the Destination device, or the Destination device could read the data from the Origination device.
m. NETWORK PROTOCOL – The protocol used to transport the peer data.
n. NOTES – Miscellaneous notes specific to the database point.

HOST PACK TEMPLATE

FACILITY:

HOST/HMI NAME

Host SCADA Configuration Information										
HOST TAGNAME	DB TYPE	HOST DESCRIPTION	ACTIVE STATE	INACTIVE STATE (0)	ALARM STATE	LO LO ALARM	LO ALARM	HI ALARM	HI HI ALARM	ALARM PRIORITY

		PLC Host Read/Write Area				PLC Intermediate Area				
HOST TAGNAME	PLC/RTU EQUIPMENT TAG	HOST I/O ADDR	HOST BIT NO	HOST PLC DATA TYPE	PLC SOFTWARE TAGNAME	INT I/O ADDR	INT BIT NO	INT DATA TYPE	PLC SOFTWARE TAGNAME	PEER DEVICE?

Field Interface Area						
HOST TAGNAME	PLC/RTU SOFTWARE TAGNAME *	FIELD DEVICE TAG *	POINT TYPE *	FIELD I/O ADDR *	FIELD BIT NO *	NOTES

LEGEND

	Engineer provides information
	Contractor provides information
	Systems Integrator/Programmer provides information
*	Common field to Field I/O List or Peer to Peer

TYPICAL FIELD INPUT/OUTPUT LIST

FACILITY:

PLC/RTU EQUIPMENT TAG: * *****

RACK NAME	FIELD DEVICE TAG *	DESCRIPTION	CARD/ MODULE TYPE	POINT TYPE	DROP	RACK / BASE	SLOT	I/O POINT	CARD/MODULE TERMINALS

END OF APPENDIX B

SECTION 13390

APPENDIX C – AW SOFTWARE TAGGING CRITERIA

For signals associated with a stand-alone instrument:

PPPPPP_TTTTTT_IIII_QQ

Where,

- PPPPPP = Process Identifier (abbreviation for process fluid shown on P&IDs)
- TTTTTT = Function Descriptor (see Austin Water Software Tag Function Descriptors table)
- IIII = Unique Identifier (Loop numbers for instrument - limited to 4 characters)
- QQ = Qualifier (see Table 3-4, AW Primary Qualifier Codes)

For signals associated with a piece of equipment:

PPPPPP_TTTTTT_IIII_QQ

Where,

- PPPPPP = Equipment Code (as will be entered in INFOR)
- TTTTTT = Function Descriptor (see Austin Water Software Tag Function Descriptors table)
- IIII = Unique Identifier (Equipment ID - limited to 4 characters)
- QQ = Qualifier (see Table 3-4, AW Primary Qualifier Codes)

Function Descriptor Codes

The function descriptor code is a four character code used to indicate the specific equipment data being represented by the software point. Examples of equipment data include motor status, motor fault, motor start/stop commands, etc. The following tables list the function descriptor code available for use.

11/12/2013

Austin Water Software Tag Function Descriptors

Code	Type	Description
AAH	Input	High Analyzer Concentration Alarm
AAL	Input	Low Analyzer Concentration Alarm
ACNC	Input	Active Concentration
ACTP	Input	Analog Cell Temperature
ACTV	Input	Active or in Progress
AFB1	Input	Auto Flow Pace - Flow Meter 1
AFB2	Input	Auto Flow Pace - Flow Meter 2
AFBD	Input	Auto Flow Pace - Calculated Data
AFBF	Input	Auto Flow Pace - Flow Meter
ALCR	Input	Critical Alarm
ALMN	Input	Maintenance Alarm
ALARM	Input	Alarm
ALRT	Input	Alert
ALTSW	Input	Alternate Switch
AMPH	Input	High Amp
AMPL	Input	Low Amp
AMPS	Input	Amps
ASIL	Input	Motor Auto Stop Interlock
ATPT	Input	Attempt (used for substation transfer attempt Counter)
AUTO	Input	Auto
AVG	Input	Average Selected
BATA	Input	PLC Controller Battery A Alarm
BATB	Input	PLC Controller Battery B Alarm
BATGEN	Input	Generator Battery Alarm
BFTC	Input	Breaker Fail to Close
BFTO	Input	Breaker Fail to Open
BKAC	Input	Breaker Ok to Close
BKRC	Input	Breaker Closed
BKRO	Input	Breaker Open
BKWF	Input	Filter Backwash Sequence Failure Alarm
BKWH	Input	Strainer in Backwash
BKWM	Input	Filter in Manual Backwash Mode
BLCB	Input	Level Control Band
BYP	Input	Bypass (e.g., UPS)
CAPC	Input	Metering Pump Capacity
CALFLW	Input	Calculated Flow
CALLFL	Input	Call Fail
CBLA	Input	Global Communications Cable A Fault
CBLB	Input	Global Communications Cable B Fault
CFLA	Input	Communications Fail Channel A

Austin Water Software Tag Function Descriptors

Code	Type	Description
CFLB	Input	Communications Fail Channel B
CHCK	Input	Check Valve Fail to Open
CLFH	Input	Hypochlorite Generator High Cell Flow
CLFL	Input	Hypochlorite Generator Low Cell Flow
CLOCK	Input	PLC Clock
CLOS	Input	Close
CLRUN	Input	Call to Run
CLSD	Input	Limit Switch Closed
CLTP	Input	Hypochlorite Generator Cell Temperature
CMERAV	Input	Total Communication Errors Average
CMERLG	Input	Total Communication Good
CMERT	Input	Total Communication Errors
CMFL	Input	Communication Fail
CMPLD	Input	Last Poll Period
CMTRLT	Input	Total Comm Transmissions
CNRA	Input	Polymer Mixing Unit Centrifuge Not Run Alarm
COMERR	Input	Communication Error
CPRM	Input	Close Permissive
CPUSTA	Input	CPU Status Diagnostic
CRSW	Input	Current Switch
CRTM	Input	Time Until Next Cleaning
CYAC	Input	Cycle Timer Accumulated Time
CYCR	Input	Cycle Freq Timer
CYRM	Input	Remaining Time Until Next Cycle
CYSP	Input	Cycle Stop
CYST	Input	Cycle Start
DATAQL	Input	Data Quality
DAY	Input	PLC Clock Day of Month
DENS	Input	Chemical Density
DRAC	Input	Duration Timer Acc Val
DRRM	Input	Time Remaining Until Duration Ends
DRPS	Input	Duration Timer Reset
DSBL	Input	Disable
DSCH	Input	Discharge Rate
DSTC	Input	Discharge to Chlorine (App Point Chlorine Injection Vaults 1-4)
DSTF	Input	Discharge to Filters (App Point is Filtered Water Injection Vault)
DSTN	Input	Discharge to None (Application Point is Not Selected
DSWF	Input	Lime Slaker Discharge Weight Fault
EMRG	Input	Emergency (e.g., ATS in Emergency Power)

Austin Water Software Tag Function Descriptors

Code	Type	Description
ENAB	Input	Enable Control Status
ENAX	Input	Enable State X
ENBL	Input	Enabled (e.g., Auto Transfer at SUB enabled)
ESL	Input	Undervoltage Alarm
ESTP	Input	Emergency Stop
ET	Input	Voltage
EUH	Input	High Engineering Units
EUL	Input	Low Engineering Units
EXRNTM	Input	Extensive Run Time
EYEW	Input	Eyewash Station No. 1 Flow Switch High
FAIL	Input	Failure (e.g., PLC Fail
FAUL	Input	Fault (e.g., Lime Slurry Aging Tank Mixer Fault)
FAUT	Input	Motor Flow Pacing Auto Control Status
FDFA	Input	Flow Rate Difference Alarm (e.g., delta between calculated and actual flow)
FIT	Input	Flow Indicating Transmitter / Signal
FILFMX	Input	Lifetime Max Flow
FITOMX	Input	Today’s Max Flow
FIYEMC	Input	Yesterday’s Max Flow
FLOW	Input	Flow/Flow Mode
FLWO	Input	Flow Pacing Selection Reset
FLWC	Input	Hypochlorite Generator Cell Flow
FLWX	Input	Flow X Selected for Flow Pacing
FQAC	Input	Frequency Timer Accumulated Value
FQICUR	Input	Current Day Flow Total
FQILF	Input	Lifetime Flow Total
FQIPRE	Input	Previous Day Flow Total
FQITOT	Input	Calculated Flow Total
FQPS	Input	Frequency Timer Preset
FRDH	Input	Flow rate difference high (when instrument flow compared to calculated flow)
FRFS	Input	Fail to reach flow setpoint
FRPS	Input	Fail to reach position setpoint
FSL	Input	Low Flow Switch
FSP_ACC	Input	Accumulated Fail to Stop Time
FSRT	Input	Fail to Start
FSTP	Input	Fail to Stop
FTAC	Input	Fail Timer Accumulated Value
FTC	Input	Fail to Close
FTO	Input	Fail to Open
FTPS	Input	Fail Timer Preset
FUSB	Input	Fuse Blown

Austin Water Software Tag Function Descriptors

Code	Type	Description
FXRM	Input	Fixed Rate Mode (vs. Level Rate Mode)
GRND	Input	Ground Fault Alarm
HDLS	Input	Headloss (e.g., filters)
HDWR	Input	Hardware
HLTH	Input	PLC Power & Scan Health Status
HOLD	Input	Hold Calculation Command
HOPP	Input	Hopper
HOUR	Input	PLC Clock Hour (Military) from Host
HTBT	Input	Heartbeat (Used for communication check)
HRUN	Input	High Speed Running Status
HSTR	Input	Motor High Speed Start Command
HVR	Input	Voltage High (e.g., battery)
ILCK	Input	Interlock
INIT	Input	Total Run-time Alarm/Hours Reset
ISRV	Input	In Service Command
KILK	Input	Key Interlock
KQAH	Input	Motor Service Alarm
KQI	Input	Runtime
KQI1	Input	Service Runtime
KQI2	Input	Lifetime Runtime
KQI3	Input	Runtime Since Start
KQILF	Input	Lifetime Runtime
KQIMN	Input	Monthly Runtime
KQIMP	Input	Previous Monthly Runtime
KQITO	Input	Today’s Runtime
KQIYE	Input	Yesterday’s Runtime
KWHMG	Input	KWH / MG Today
KWHMG	Input	KWH / MG Yesterday
LAUT	Input	Motor Local Auto Control Status
LAGPMP	Input	Lag Pump Run
LCRM	Input	Equipment in Local or Remote
LDRA	Input	Level Decline Rate Alarm
LDRD	Input	Level Decline Rate Difference
LEAD	Input	Equipment is Load
LEAK	Input	Leak indication (.g., high gas concentration)
LEVEL	Input	Level
LGPSTS	Input	Lag Pump Starts Today
LI2DMN	Input	Minimum Level from 2 Days ago
LI2MDX	Input	Maximum Level from 2 Days ago

Austin Water Software Tag Function Descriptors

Code	Type	Description
LIT	Input	Level Indicating Transmitter
LITOMN	Input	Today's Level Minimum
LITOMX	Input	Today's Level Maximum
LIWF	Input	Lime Slaker Lime Inlet Weight Fault
LIYEMN	Input	Yesterday's Level Minimum
LIYEMX	Input	Yesterday's Level Maximum
LMAN	Input	Motor Local Manual Control Status
LMWT	Input	Lime Weight
LOAL	Input	Lockout Alarm
LOCK	Input	Lockout
LOCL	Input	Local
LOGC	Input	Controller A/B Logic Mismatch
LRUN	Input	Low Speed Running Status
LSHH	Input	Level Switch Hi-Hi
LSH	Input	Level Switch Hi
LSLL	Input	Level Switch Lo-Lo
LSL	Input	Level Switch Lo
LSTR	Input	Motor Low Speed Start Command
LVHH	Input	Level Hi-Hi
LVLB	Input	Level of Brine
LVLL	Input	Level Lo-Lo
LVLN	Input	Level of Salt
LVLQAI	Input	Level Data Quality
LVLX	Input	Level X Selected
LVR	Input	Voltage Low (e.g., battery)
LVRM	Input	Level Rate Mode (vs. Fixed Rate Mode)
LY	Input	Bubbler / Level Transmitter Fail
MAN	Input	Manual
MDBBD	Input	Modbus Baud
MDBDL	Input	Modbus Data Length
MDBDP	Input	Modbus Data Parity
MDBRT	Input	Modbus Retries
MDBSB	Input	Modbus Stop Bit
MDBTO	Input	Modbus Timeout
MDFT	Input	Frequency Timer Mode
MDSP	Input	Sludge Pump Mode (UFC Residual)
MIN	Input	Clock Minute
MLR	Input	Motor Lockout Relay
MNFL	Input	Manual Flow
MNPS	Input	Manual Position Mode

Austin Water Software Tag Function Descriptors

Code	Type	Description
MNSP	Input	Manual Speed SP Mode
MNTN	Input	Maintenance Mode
MODALN	Input	Module (IO) Alarm
MODBD	Input	Modem Baud
MODDL	Input	Modem Data Length
MODDP	Input	Modem Data Parity
MODE	Input	Status or Mode
MODSB	Input	Modem Stop Bit
MONTH	Input	Clock Month
MPR	Input	Motor Protector Relay Alarm
MSIL	Input	Motor Manual Stop Interlock
NSH	Input	Hi Torque Alarm
NCR	Input	No Charge (e.g., battery)
NDST	Input	Output to No Destination (e.g., metering pumps)
NGR	Input	Negative Ground (e.g., battery)
NLRM	Input	None in Level Rate Mode Alarm (UFCs)
NMSTOP	Input	Normal Stop Cycle
NORM	Input	Normal (e.g., ATS Normal Power
NOTAVL	Input	Not Available
NOTK	Input	Standby Controller Not On LAN
NSH	Input	Hi Torque Switch
NSHH	Input	Hi-Hi Torque Alarm
NSHHH	Input	Drive Motor Cut Out Torque Alarm
NUMBR	Input	Telephone Number
OAAF	Input	Operator Adjustable Adjustment Factor (e.g., metering pump dose calculations)
OFAC	Input	Cycle Timer Off Accumulated Valve
OFF	Input	Off Status
OFFX	Input	Disable State X Command
OFLN	Input	Offline
OFPS	Input	Cycle Timer Off Preset
ON	Input	On / Running
ONAC	Input	Cycle Timer On Accumulated Value
OPEN	Input	Open Status
ONPS	Input	Cycle Timer On Preset
OPRM	Input	Open Permissive
OORAIX	Input	Out of Range for Analog Input Channel X
OORAOX	Input	Out of Range for Analog Output Channel X
OSRV	Input	Out of Service Command
OVLD	Input	Overload

Austin Water Software Tag Function Descriptors

Code	Type	Description
PBSP	Input	Push Button Stop (e.g., LSPS)
PBST	Input	Push Button Start (e.g., LSPS)
PDAH	Input	High Differential Alarm
PFLD	Input	Power Factor Lead
PFLG	Input	Power Factor Lag
PFOL	Input	Power Factor Capacitor Overload
PGR	Input	Positive Ground Detect (e.g., battery charger)
PICK	Input	Pickup Coil
PING	Input	PING (e.g., PLC PING status)
PIT	Input	Pressure Indicating Transmitter
PMPX	Input	Pump X Selected
PNLF	Input	Front Panel Open
POLLCD	Input	Poll Command
POLLST	Input	Last Poll Status
PRTY	Input	Chemical Purity
PRMA	Input	Controller A is Primary
PRMB	Input	Controller B is Primary
PROC	Input	Motor Process Permissive
PSAC	Input	Parallel Source Active (e.g., SUB1)
PSAL	Input	Parallel Source Alarm (e.g., SUB1)
PSH	Input	Pressure Switch High
PSL	Input	Pressure Switch Low
PSTR	Input	Motor Pending Startup Status
PWRA	Input	Power Fail A
PWRB	Input	Power Fail B
QFEF	Input	Filters Effluent Flow Dosage Point
QRWF	Input	Raw Water Flow to Clarifiers Dosage Point
RAIXHD	Input	RTU Analog Point ‘X’ Health Diagnostic
RALL	Input	Remote Auto Lead-Lag Control Mode
RALM	Input	Resettable Alarm
RAPR	Input	Remote Auto Percentage mode
RAUT	Input	Motor Remoter Auto Control Status
RDY	Input	Equipment Ready Status
REFVLP	Input	Reference Voltage Positive
REFVLN	Input	Reference Voltage Negative
RIOP	Input	Global Communications RIO Health Fault
RKXFLT	Input	Rack Fault for Rack No. ‘X’
RMDXHD	Input	RTU Module ‘X’ Health Diagnostic Status
RMOT	Input	Remote
RSET	Input	Alarm Reset

Austin Water Software Tag Function Descriptors

Code	Type	Description
RSME	Input	Resume Calculation Command
RTHI	Input	Runtime Hi Alarm
RTMH	Input	Rectifier High Temp Hi
RTODDT	Input	RTU Time Of Day – Date
RTODDY	Input	RTU Time Of Day – Day
RTODHR	Input	RTU Time Of Day – Hour
RTODMN	Input	RTU Time Of Day – Minute
RTODSC	Input	RTU Time Of Day – Second
RTODYR	Input	RTU Time Of Day – Year
RTS	Input	Return to Service
RUNA	Input	Running Alarm
RUNC	Input	Close Contactor is Energized (e.g., electric actuator)
RUNN	Input	Motor Running
RUNO	Input	Open Contactor is Energized (e.g., electric actuator)
RUNTIME	Input	Service Time Preset/Reset Value
RVSF	Input	RVSS (Reduced Voltage Solid-state Starter) Fault
RXXSTA	Input	Rack 0 Slot XX Status (OK)
S908	Input	Global Communications Health Fault
SAFE	Input	Motor Safety Permissive (Future)
SALM	Input	Alarm Exists
SAUT	Input	Motor Speed Auto Control Status
SBYA	Input	Controller A is Standby
SBYB	Input	Controller B is Standby
SCAN	Input	PLC Scan Time
SCLB	Input	Scale Buildup (Lime Slaker)
SCLH	Input	Scale Buildup High Alarm (Lime Slaker)
SEC	Input	Clock Seconds
SELX	Input	State X Selected
SHDN	Input	Shutdown Alarm
SHOL	Input	Space Heater Overload
SILK	Input	Motor Stop Interlock
SLTL	Input	Salt Tank Low
SOFF	Input	Selector Switch in OFF
SON	Input	Selector Switch in ON
SPRM	Input	Start Permissive
SRAM	Input	PLC State RAM
ST	Input	Speed Feedback
STBY	Input	Stand-by Status
STDN	Input	Shutdown

Austin Water Software Tag Function Descriptors

Code	Type	Description
STEP	Input	Sequence Step
STLF	Input	Lifetime Starts
STRK	Input	Stroke
STRT	Input	Motor Start
STOP	Input	Motor / Valve Stop
STSEXD	Input	Starts Exceeded
STSEXB	Input	Starts Exceeded Bypassed
STTO	Input	Today's Starts
STYE	Input	Yesterday's Starts
SUCC	Input	Success
SURG	Input	Surge Alarm
SWAP	Input	PLC Swap Over Command
SYNC	Input	Sync Check Relay
TALM	Input	Temperature Alarm
TDAC	Input	Time Delay Off Accumulated Value
TEMP	Input	Temperature
TIMSTP	Input	Time Stamp
TGON	Input	Tagout On
TOC	Input	Truck Operated Contact (Vacuum Circuit Breaker)
TODFUL	Input	Time of Day Events Full
TODNUM	Input	Time of Day Events Number
TODSYN	Input	Synch RTU Clock to FEP
TOKN	Input	Token Rotation Time in secs
TOTL	Input	Total
TRBL	Input	Trouble (Malfunction) Alarm
TSH	Input	High Temperature Switch
TSL	Input	Low Temperature Switch
UFRV	Input	Unit Filter Run Volume
UPSB	Input	UPS Low Battery
UPSF	Input	UPS Fail
VFDA	Input	VFD Alarm
VFDT	Input	VFD Temperature Alarm
VFTC	Input	Valve Fail to close
VFTO	Input	Valve Fail to open
VSH	Input	High Vibration
VSHH	Input	High High Vibration
VSL	Input	Low Vibration
WALM	Input	Weight Alarm

Austin Water Software Tag Function Descriptors

Code	Type	Description
WARN	Input	Warning
WIWF	Input	Water Inlet Weight Fault (Lime Slaker)
WSFL	Input	Weight Sensor Fault (e.g., Lime Slurry Aging Tank)
WY	Input	Weight Tared
XA	Input	Surge Suppressor Alarm
XFER	Input	Transfer Relay (e.g., initiates SUB1 transfer algorithm)
XHK	Input	Dosage Set point
XHLD	Input	Hold Calculation Status
XMTECD	Input	Transmit Error Code
XMTEND	Input	Transmit Error Node
XS	Input	General Switch Input
XSRV	Input	Filter In Service Status
XTND	Input	Filter Extend Backwash Notification
XTON	Input	Filter Extend Backwash On Status
XTOP	Input	Stop
XQI	Input	Current Day Start Count
XYSN	Input	Module Health Drop X Rack Y Slot N
YEAR	Input	Clock Year
ZA	Input	Valve Fail Alarm
ZDO	Input	Zero Dropout Value
ZS	Input	General Switch Input
ZSC	Input	Position switch close
ZSO	Input	Position switch open
ZT	Input	Position Feedback
AHK	Output	Remote Analyzer Setpoint
CLOS	Output	Equipment Close Coil
CYPS	Output	Cycle Preset Time Setpoint
DRPS	Output	Duration Preset Time Setpoint
FHK	Output	Flow Setpoint
FHKx	Output	Flow Setpoint, where x is a unique digit (when multiple setpoints used)
FIC	Output	Flow Controller Output
HSTR	Output	High Speed Start Coil
HXTP	Output	High Speed Stop Coil
KQC	Output	Runtime Reset Value
LHK	Output	Level Setpoint
LHKx	Output	Level Setpoint, where x is a unique digit (e.g., used in multi-level setpoints for tanks)

Austin Water Software Tag Function Descriptors

Code	Type	Description
LSTR	Output	Low Speed Start Coil
LXTP	Output	Low Speed Stop Coil
MNRTSP	Output	Minimum Pump Runtime Setpoints
OFFSP	Output	Off Setpoint
ONFR	Output	Online Fixed Rate Mode Command
ONLR	Output	Online Level Rate Mode Command
ONSP	Output	On Setpoint
OPEN	Output	Equipment Open Coil
RNTRST	Output	Runtime Reset
RSET	Output	Reset Command
RST1	Output	Reset Service Runtime Command
RST2	Output	Reset Life Runtime Command
RVAL	Output	Equipment Runtime Preset Value
SHK	Output	Speed Setpoint
SHKx	Output	Speed Setpoint, where x is a unique digit (when multiple setpoints used)
SPBD	Output	Stop Blowdown Command
SRINSP	Output	Service Alarm Interval Setpoint
STBD	Output	Start Blowdown Command
STOP	Output	Stop Command
STRT	Output	Start Command
TGDT	Output	Tagout Date Setpoit
TGRN	Output	Tagout Reason Setpoint
TGRS	Output	Tagout Reset Command
TGST	Output	Tagout Set Command
TGTM	Output	Tagout Time Setpoint
TGUS	Output	Tagout User Setpoint
XFER	Output	Transfer Coil
XHK	Output	Dosage Setpoint
XHKx	Output	Dosage Setpoint, where x is a unique digit (when multiple setpoints used)
XRUN	Output	Motor Run / Stop Coil
XTOP	Output	Motor Stop Coil
ZHK	Output	Position Setpoint
ZHKx	Output	Position Setpoint, where x is a unique digit (when multiple setpoints used)
ZVC	Output	Valve Close Command
ZVO	Output	Valve Open Command
ZVC	Output	Valve Open / Close Coil

Table 3-4
Primary Qualifier Codes

Qualifier Code	Description
I	Field inputs to PLC.
O	Field outputs from PLC.
F	Filtered values/coils (used for existing software tag names only).
HI	Host inputs read from PLC.
HR	Host register read from/written to PLC.
M	Logic modified values/coils.
P	Peer-to-Peer points.
S	Scaled values.
DW	Host write to data source.
DR	Host read from data source.
PB	Primary Block.
CSB	Secondary Block.
LHI	Local Host (OIU) inputs read from PLC.
LHO	Local Host (OIU) outputs written to PLC.
LHR	Local Host (OIU) register read / wire to PLC

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SECTION 13446

MANUAL ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Valve and gate actuators.
   2. Handwheel actuators.
   3. Hand-cranked geared actuators.
   4. Accessory equipment and floor boxes.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45 - Designation System for Aluminum Finishes.

B. American Water Works Association (AWWA).

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. National Electrical Code (NEC).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.
   2. Type 7 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Shop drawings: Include shop drawings and product data with associated gate or valve as an integrated unit.

1.05 QUALITY ASSURANCE

A. Provide valve actuators integral with valve or gate, except for valve actuators utilizing T-wrenches or keys, and portable gate actuators intended to operate more than 1 valve.

B. Provide similar actuators by 1 manufacturer.

C. Provide gates and hand operating lifts by 1 manufacturer.

D. Provide hydraulic gate lifts by 1 manufacturer.

E. Provide hydraulic valve actuators and motorized actuators by 1 manufacturer.

PART 2 PRODUCTS

2.01 VALVE AND GATE ACTUATORS

A. Valve actuators:
   1. Cylinder actuators, motorized actuators, and portable gate actuators are specified in Sections 13447 - Electric Motorized Actuators.
   2. Manual actuators:
      a. Unless otherwise specified on the drawings or in the equipment specification, all gates and valves 8-inches and larger shall be handwheel actuated. Valves less than 8-inches shall be lever actuated.
         1) Material: Type 304 stainless steel.
         2) Lever specific requirements:
            a) Spring release handle: 12-inch.
            b) Notch plate: 10 position.
            c) Secure with mounting bolts.
            d) Locking device so that valve can be locked in any position with a wing nut.
   3. Stem and cover:
      a. For submerged valves, provide extension stem as indicated on the Drawings.
   4. Limit switches: Provide limit switches on manually actuated valves where indicated on the Drawings:
      a. Limit switches: Heavy-duty, industrial grade, oiltight, with not less than 2 auxiliary contacts.
      b. Rating: Rated for 10 amps, 120 volts alternating current.
      c. Enclosure: NEMA Type 4X enclosure and with stainless steel levers and arms. Provide switch with NEMA Type 7 enclosure when switch is located within areas with NEC Class 1, Division 1 or Class 1, Division 2 designations as indicated on the Drawings.

B. Stem covers:
   1. Aluminum pipe:
      a. Threaded cap on top.
      b. Bolted aluminum flange on bottom.
      c. Slots cut 1- by 12-inch at 18 inches on center in front and back of pipe.
      d. Capable of covering threaded portion of greased stems that project above actuators when gates or valves are opened or closed.
   2. Ultraviolet light resistant, clear butyrate plastic or polycarbonate pipe:
      a. Capped on the upper end.
      b. Either threaded into the top of the gate operators or held in place by bolt-down aluminum brackets.
      c. Capable of covering threaded portion of greased stems that project above actuators when gates or valves are opened or closed.
   3. Staff gauges:
      a. Adhesive-backed mylar, suitable for outdoor service.
      b. Calibrated in hundredths of feet.
      c. Read the weir crest elevations directly.
      d. Gauge range: 1.5 feet minimum.
      e. Indicate the following elevations on each staff gauge:
         1) -0.75, -0.50, -0.25, 0.0, 0.25, 0.50, 0.75.

f. Supplement with a stem-mounted pointer or indicator that permits direct observation of the weir gate crest elevation.
g. Apply staff gauges to each stem cover after installation of the cover and after calibration and testing of the weir gates.
h. Set gauges precisely by a survey crew using instruments acceptable to the Engineer.

C. Stem cover flanges, pipes and caps:
1. After fabrication, etch and anodize to produce the following chemical finishes in accordance with AA publication DAF-45:
a. A 41 - Clear Anodic Coating.
b. C 22 - Medium Matte Finish.

D. Gate stem covers: Concentric with stem.

E. Position indicators:
1. For all aboveground worm gear or traveling nut manual actuators, provide position indication on the actuator enclosure.
2. Tail rods on hydraulic cylinders, or dial indicators with clear full-open and closed position indicators, calibrated in number of turns or percentage of opening.

F. Manual or power actuator size:
1. Sized to deliver maximum force required under most severe specified operating condition, including static and dynamic forces, seat and wedge friction, and seating and unseating forces with safety factor of 5, unless otherwise specified.

G. Actuator size: Capable of supporting weight of suspended shafting unless carried by bottom thrust bearings; shaft guides with wall mounting brackets.

H. Provisions for alternate operation: Where specified or indicated on the Drawings, position and equip crank or handwheel operated geared valve actuators or lifts for alternate operation with tripod mounted portable gate actuators.

I. Operation: Counterclockwise to open with suitable and adequate stops, capable of resisting at least twice normal operating force to prevent overrun of valve or gate in open or closed position.

J. Open direction indicator: Cast arrow and legend indicating direction to rotate actuator on handwheel, chain wheel rim, crank, or other prominent place.

K. Buried actuator housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between actuator housing and valve body so that no moving parts are exposed to soil; provide actuators with 2-inch square AWWA operating nut.

L. Worm gear actuators: Provide gearing on worm gear actuators that is self-locking with gear ratio such that torque in excess of 160 foot-pounds will not need to be applied to operate valve at most adverse conditions for which valve is designed.

M. Traveling nut actuators: Capable of requiring maximum 100 foot-pounds of torque when operating valve under most adverse condition; limit stops on input shaft of

manual actuators for fully open and closed positions; non-moving vertical axis of operating nut when opening or closing valve.

2.02 HANDWHEEL ACTUATORS

A. Manufacturers: One of the following or equal:
   1. Rodney Hunt Co.
   2. Waterman Industries, Inc.

B. Coating: Handwheel as specified in Section 09960 - High-Performance Coatings.

C. Mounting: Floor stand or bench stand. Unless otherwise indicated on the Drawings position actuator 36 inches (nominal) above top of walkway surface.

D. Bearings above and below finished threaded bronze operating nut: Ball or roller.

E. Wheel diameter: Minimum 18 inches.

F. Indicator: Counterclockwise opening with arrow, and word OPEN cast on top of handwheel indicating direction for opening.

G. Pull to operate: Maximum 40 pounds pull at most adverse design condition.

H. Stem travel limiting device: Setscrew locked stop nuts above and below lift nut.

I. Grease fittings: Suitable for lubrication of bearings.

2.03 HAND-CRANKED GEARED ACTUATORS

A. Type: Single removable crank; fully enclosed.

B. Mounting: Floor and bench stand. Unless otherwise indicated on the Drawings position actuator 36 inches (nominal) above top of walkway surface.

C. Operating nut: When scheduled for portable gate actuators.

D. Geared lifts: Single speed with minimum ratio of 2 to 1.

E. Teeth on gears, spur pinions, bevel gears, and bevel pinions: Cut.

F. Lift nuts: Cast manganese bronze.

G. Exterior surfaces on cast-iron lift parts: Smooth.

H. Bearings above and below flange on lift nuts: Ball or roller; capable of taking thrust developed by opening and closing of gates under maximum operating head; with bronze sleeve bearings and sufficient grease fittings for lubrication of moving parts, including bearings and gears.

I. Crank rotation indicator: Cast arrow with word OPEN in prominent location readily visible indicating correct rotation of crank to open gate.

J. Hand cranks: 15-inch radius; requiring maximum 25 pounds pull to operate gate at maximum operating head; with:
   1. Revolving brass sleeves.
   2. Gears, spur pinions, bevel gears, and bevel pinions with cut teeth.
   3. Cast manganese bronze lift nuts.
   4. Cast-iron lift parts with smooth exterior surfaces.

K. Indicator: Dial position type mounted on gear actuator; enclosed in cast-iron or aluminum housing with clear plastic cover; marked with fully open, 3/4, 1/2, 1/4, and closed positions.

2.04 ACCESSORY EQUIPMENT

A. Wall brackets or haunches: As indicated on the Drawings.

B. Stems: Stainless steel; sized to match output of actuator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.

C. Stem couplings: Stainless steel; internally threaded to match stem; lockable to stem by set screw.

D. Stem guides: Cast-iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with wall bracket; adjustable in 2 directions.

E. Wall brackets: Cast-iron, capable of withstanding output of actuator, adjustable in 2 directions.

F. Stem stuffing boxes: Cast-iron, with adjustable gland and packing.

G. Fasteners: Type 316 stainless steel.

H. Anchor bolts: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry except that the material shall be Type 316 stainless steel.

I. Geared valve actuators: Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40-pound pull at handwheel or chain wheel rim.

J. Geared valve traveling nut actuators: Acceptable only where specified or indicated on the Drawings.

K. Accessory equipment for valves and gates requiring remote actuators: Operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install floor boxes in concrete floor with lid flush with floor.

B. After installation of gate and stem covers, mark stem covers at point where top of stems are at full-open position and at closed position.

C. Attach floor stand to structure with anchor bolts.

D. Install stem stuffing boxes where operating stems pass through intermediate concrete floor slabs.

3.02 SCHEDULES

A. Gates and valves schedule is provided in the Drawings.

B. Geared actuators: Provide geared actuators for following valves:
   1. Butterfly valves larger than 6 inches, nominal size, on liquid service.
   2. Butterfly valves larger than 10 inches, nominal size, on gas and air service.
   3. Plug valves 6 inches, nominal size, and larger.

C. Handwheel actuators: Provide handwheel actuators for valves mounted 6 feet or less above floors.

D. Chain wheel actuators: Provide chain wheel actuators for valves mounted more than 6 feet to centerline above floors.

END OF SECTION

SECTION 13447

ELECTRIC ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Electric motor-driven actuators for valves as identified in the valves schedule in the Drawings as EAM, EDM, or EDR. Electric motor-driven actuators for gates as identified in the Specification gate schedule.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C504 - Standard for Rubber-Seated Butterfly Valves.
   2. C542 - Standard for Electric Motor Actuators for Valves and Slide Gates.

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.
   2. Type 7 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures and Section 15050 - Common Work Results for Mechanical Equipment.

B. Provide a complete list/schedule of all actuators being provided with their associated tag names as indicated on the design drawings and/or specifications, service process area and the size of the valve they are actuating.

C. All electric actuators shall be provided by one manufacturer.

D. Product data:
   1. Electrical ratings:
      a. Voltage and number of phases.
      b. Starting and running current.
      c. Voltage levels and source for control and status.
   2. Description of integral control interface.
   3. Remote control station components**.**
   4. Environmental ratings, including NEMA enclosure rating and submergence capabilities.
   5. Gear ratios for both manual and motorized actuation.
   6. Opening and closing directions.
   7. Allowable starts per hour.
   8. List of all included options and accessories.

9. Full travel times.
10. Gearbox data including gear ratio, and gearbox efficiency.

E. Shop drawings:
   1. Wiring diagrams:
      a. Include all options and expansion cards furnished with each actuator.
   2. Dimensioned drawings of each valve and actuator combination.
   3. Dimensioned drawings of each valve gearbox.
   4. Electric motor data.

F. Calculations:
   1. Operating torque.
   2. Maximum torque calculations for seating and unseating.
   3. Maximum operating torque at starting and normal operation.
   4. Signed by Professional Engineer.

G. Provide draft vendor operation and maintenance manual as specified in Section 01730 - Operation and Maintenance Manuals:
   1. Include a list of all configurable parameters, and the final values for each.
   2. Include a troubleshooting chart covering the complete valve and controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.

H. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
      a. Affidavit in accordance with AWWA C542.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

I. Project closeout documents:
   1. Provide final vendor operation and maintenance manual as specified in Section 01730 - Operation and Maintenance Manuals.

1.05 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers for lines 4 inch and larger:
   1. One of following or equal:
      a. Rotork Controls Inc. IQ3 Range:
         1) IQ for multi-turn applications.
         2) IQT for quarter-turn applications.
      b. Limitorque Corp.:
         1) Accutronix MX for multi-turn applications.
         2) Accutronix QX quarter-turn applications.
      c. Auma:
         1) SA (multi-turn) with Aumatic AC controls.

2) SQ (quarter-turn) with Aumatic AC controls.

2.02 CHARACTERISTICS FOR ACTUATORS ON LINES 4 INCHES AND LARGER

A. Provide actuators complete and operable with all components and accessories required for operation.

B. Power supply:
   1. Voltage and phases as indicated in the Motorized Actuator Schedule.
   2. Valve or gate motion independent of power supply phase rotation.
   3. Provide an internal backup power source or mechanical indicator to maintain settings and track valve position when main power is off.
   4. The actuators shall incorporate all major components such as the motor, starter, local controls, terminals, etc. housed within a self-contained, sealed enclosure.

C. Size actuator to move gates or valves from full open to closed position within the time indicated in the Motorized Actuator Schedule:
   1. If an operating time is not indicated on the Motorized Actuator Schedule, size the actuator to move gates or valves at minimum 12 inches per minute under maximum load. Measure rate of closure for valves at maximum diameter of disc, plug, or ball.
   2. Size actuators so that gear boxes are not required where possible.

D. Control interface:
   1. Configuration:
      a. Provide a non-intrusive, non-contacting interface for configuring all input and output settings, control values, ranges, torque switch settings, valve positions switch settings, and options.
         1) Configurable from a handheld configuring tool or input devices on the actuator.
   2. Local interface, integral to actuator:
      a. Non-intrusive, non-contacting selector switches:
         1) LOCAL-OFF-REMOTE:
            a) Motor actuator operation is prevented with the switch in OFF.
         2) OPEN-CLOSE:
            a) Controls the valve when LOCAL-OFF-REMOTE is in LOCAL.
            b) Spring return to center.
            c) Configurable between maintained (actuator runs until end of travel, high torque, or a LOCAL-OFF-REMOTE is switched to OFF) and momentary (actuator stops when lever is released).
      b. Local display:
         1) Valve fully open and fully closed indicators.
         2) Numerical display showing actual valve or gate position in percent of travel.
   3. Control inputs:
      a. Capable of using 120 VAC or 24 VDC inputs.
      b. Controls the valve when LOCAL-OFF-REMOTE is in REMOTE.

c. Isolated inputs capable of operating from external control voltage source or internal power supply:
    1) Furnish 120 VAC or 24 VDC control power supplies within the actuator.
d. Provide the following inputs:
    1) OPEN.
    2) CLOSE.
    3) STOP.
e. OPEN and CLOSE inputs configurable between maintained (actuator runs until end of travel, high torque, or an OFF input) and momentary (actuator stops when command is removed).

4. Status outputs:
    a. Monitor relay output: Dry contact, normally closed, opens when actuator is not in REMOTE or in the event of any internal fault or alarm condition.
    b. Dry contact outputs configured for the functions indicated on the Drawings. Provide the following outputs for all actuators:
        1) Fully closed.
        2) Fully open.
        3) LOCAL-OFF-REMOTE in REMOTE position.
    c. All output contacts rated for 5 amps, 120 VAC, and 24 VDC.
5. Analog input:
    a. Provide a 4-20 milliampere analog input for analog modulating valves when indicated on the Drawings.
    b. Modulate valve to maintain position based on analog input value.
    c. Maximum input impedance 250 ohms.
6. Analog outputs:
    a. Provide an isolated 4-20 milliampere analog outputs when indicated on the Drawings.
        1) Loop power sourced from the actuator power supply.
        2) Capable of driving into a load up to 500 ohms.
        3) Output proportional to process value(s) indicated on the Drawings.
        4) Valve or gate position.
        5) Operating torque.
7. Network communications:
    a. As shown on drawings:

E. Features:
1. Time delay on reversal: Incorporate time delay between stopping actuator and starting in opposite direction to limit excessive current, torque, and heating from instantaneous reversal.
2. Data logging:
    a. Store diagnostic data and reference data.
    b. Time-stamped historical operating data, including number of operations.
    c. Starting torque, maximum running torque, and end of travel torque.
        1) Store reference data (recorded during commissioning) and data from last operation.
3. Provide display of logged data on the actuator, or provisions to download to a personal computer.

F. Materials:
   1. Construct motorized actuators of materials suitable for the environment in which the valve or gate is to be installed.

G. Components:
   1. Motors:
   2. Specifically designed for valve actuator service with high starting torque, totally enclosed non-ventilated construction.
   3. Torque ratings equal to or greater than that required for valve seating and dynamic torques with a 25 percent factor of safety.
      a. Design requirements for rubber-seated AWWA butterfly valves:
         1) Design actuators for maximum gate or valve operating torque, in accordance with and using safety factors required in AWWA C504 and AWWA C542.
            a) Valve actuator torque requirement for open-close service: Not less than the required valve-seating and dynamic torques under design operating conditions in accordance with AWWA C504.
            b) Valve actuator torque requirement for modulating service: Not less than twice the required valve dynamic torque under design operating conditions in accordance with AWWA C504.
      b. Design requirements for slide gates, gate valves, knife gate valves, globe valves, and diaphragm valves:
         1) Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C542.
         2) Design for the maximum torque and thrust running load over the full cycle.
         3) Maximum torque or thrust rating: The actuator stall torque or maximum thrust output shall not exceed the torque or thrust capability of the valve or gate, as determined by the valve or gate manufacturer.
   4. Capable of being removed and replaced without draining the actuator gear case.
   5. Motor bearings shall be amply proportioned of the anti-friction type and permanently lubricated.
   6. Rated for operating under the following conditions without exceeding temperature limits with ambient temperature of 40 degrees Celsius.
      a. Continuous operation for 15 minutes or twice the open-to-close operating time (whichever is greater) at normal operating torque or 33 percent of maximum torque (whichever is greater).
      b. 60 starts per hour for open/close service or 1,200 starts per hour for modulating service.
   7. Provide the following motor protection features:
      a. Jammed valve (no valve motion detected through a time delay).
      b. High motor temperature (sensed by an embedded thermostats).
      c. High torque.
      d. Single phasing protection.

H. Enclosures:
    1. Actuator housing ratings as indicated in the Motorized Actuator Schedule.
    2. Stainless steel external fasteners.
    3. Provide o-ring seals for each of the following areas:
        a. Between the terminal compartment and the internal electrical elements.
        b. Between the mechanical and electrical portions to protect from the ingress of oil, and to protect the mechanical components of oil from dust and moisture when the electrical terminal is open.
    4. Provide the following minimum enclosure ratings:
        a. NEMA Type 4X enclosure for general applications.
    5. NEMA Type 7 certified by FM for Class I, Division 1, Groups C, D, E, F, and G, for actuators installed in Class I, Division 1 and 2 areas.

I. Position sensing:
    1. Electronic and adjustable using a solid-state encoder wheel.
        a. Mechanical limit switches and potentiometers are not acceptable.
    2. Capable of retaining position and monitoring valve or gate motion when valve is manually actuated and when main power is not present.
    3. Valve range and position switch outputs field adjustable.

J. Torque sensing:
    1. Torque shutdown setting: 40 percent to 100 percent rated torque:
        a. Adjustable in 1 percent increments.
    2. Capable of interrupting control circuit during both opening and closing and when valve torque overload occurs.
    3. Electrical or electronic torque sensing.
    4. Independent of variations in frequency, voltage, or temperature.
    5. Provide a temporary inhibit of the torque sensing system during unseating or during starting in mid-travel against high inertia loads.
    6. Provide visible verification of torque switch status without any housing disassembly.

K. Manual actuators:
    1. Hand wheel for manual operation.
        a. Maximum 80-pound pull on rim when operating gate or valve under maximum load.
        b. Provide pull chain when motorized actuator is located more than 6 feet above floor surface.
            1) Chain shall be of sufficient length to reach approximately 4 feet above the operating level.
            2) Where the chain obstructs an aisle or walkway, provide holdback or other means to ensure chain does not create a nuisance or hazard to operating personnel.
    2. Declutch lever: Padlockable, capable of mechanically disengaging motor and related gearing and freeing hand wheel for manual operation.

L. Gearing: Hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set.
    1. Accurately cut to ensure minimum backlash.

M. Bearings:
   1. Anti-friction bearing with caged balls or rollers throughout.
   2. Sealed-for-life type thrust bearings housed in a separate thrust base.

N. Drive bushing:
   1. Easily detachable for machining to suit the valve stem or gearbox input shaft.
   2. Positioned in a detachable base of the actuator.

O. Lubrication:
   1. Provide totally enclosed actuator gearing with oil or grease filled gear case suitable for operation at any angle.
   2. Actuators requiring special or exotic lubricants are not acceptable.

2.03 ACCESSORIES

A. Software:
   1. Furnish PC-based diagnostic and configuration software to display diagnostic data.
   2. Provide software communications to the valve actuator using Bluetooth wireless or IrDA infrared communications.
      a. Provide all accessories and drivers required for operation and communications with a standard personal computer running Microsoft Windows.
      b. Where infrared communications are used, furnish an IrDA to USB adapter with a mounting device to secure the infrared element to the valve actuator IrDA port:
         1) Provide with a minimum cable length of 3 feet, capable of being extended with a standard USB extension cable.]

B. Termination module cover:
   1. For actuators on a valve network, provide a means to keep the valve network in service, in the event where the actuator must be removed.
   2. Provide sunshades for all outdoor installations of remote control stations that use an LCD or similar screen. Regular pushbutton, sector switches, and pilot light control stations will not require a sunshade.

2.04 SPARE PARTS AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements.

B. Spare parts:
   1. Provide the following (minimum 10 percent of total number of actuators of each model type furnished, but not less than 1 for each model of actuator furnished):
      a. Stem nut.
      b. Worm shaft subassembly.
      c. Drive sleeve subassembly.
      d. Complete actuator seal kit.
      e. Actuator gearbox oil (sufficient quantity to fill 4 gearboxes).
      f. Encoder.
      g. Control module.
   2. Provide 1 spare motor for each size motor furnished.

C. Setting tool:
    1. If required for setting or configuring the actuator, provide a handheld setting tool.
        a. Furnish 1 setting tool for every 10 actuators.
        b. Capable of communicating with PC-based configuration software, and transferring the following in either direction between the computer and programmer and setting tool, and between the setting tool and actuator.
        c. Actuator configurations:
            1) Capable of storing up to 10 different configurations.
        d. Diagnostic data:
            1) Capable of storing 4 complete sets of diagnostic data.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Position visual indicators so that they are most easily visible.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning, Section 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
    1. Provide certificates:
        a. Manufacturer's Certificate of Source Testing:
            1) Proof-of-Design and Performance Test Reports in accordance with AWWA C542.
        b. Manufacturer's Certificate of Installation and Functionality Compliance.
    2. Manufacturer's Representative on-site requirements:
        a. Installation: 2 trips, 2-day minimum each.
        b. Functional testing: 2 trips, 2-day minimum each.
    3. Training:
        a. Maintenance: 2 hours per session, 1 session
        b. Operation: 1 hours per session, 1 session.

C. Source testing:
    1. Design and Performance Test Reports in accordance with AWWA C542.
    2. Test each actuator with a simulated load.
        a. Simulate a typical valve load.
    3. Electrical Instrumentation and Controls:
        a. Test witnessing: not witnessed.
        b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

D. Functional testing:
   1. Installed actuator:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Tests.
      c. Conduct Level 2 Vibration Tests.
      d. Conduct Level 2 Noise Tests.
   2. Electrical Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

3.03 MOTORIZED ACTUATOR SCHEDULE

A. Provide all actuators indicated on the Drawings:
   1. Major process actuators are listed in the Equipment and Valve Schedule indicated on the Drawings.
   2. The Equipment and Valve Schedule includes all number and types of actuators required for the Project for valves 4in and greater.

B. Abbreviations relating to type:
   1. BFV = Butterfly Valve.
   2. BV = Ball Valve.
   3. PV = Plug Valve.
   4. SG = Slide Gate.

C. Abbreviations relating to actuator type:
   1. O/C = Open and Close Service.
   2. MOD = Modulating Service.

D. Abbreviations relating to controls:
   1. A = Analog (4-20 mA) control, modulating duty.
   2. D = Discrete control, modulating duty.
   3. D-O/C = Discrete Open/Close.

END OF SECTION

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SECTION 13851

FIRE ALARM SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Scope of Work

1. A single Fire Alarm System Contractor (FASC) shall furnish all services and equipment as defined herein and in other Specification sections as listed below under Related Requirements. The FASC shall have the qualifications as described in subsection 1.02 “Related Requirements”, this Section of the Specifications.
2. Furnishing a complete system design responsibility for the fire alarm system design for the Substation No. 1 Building and the Administration Building accompanied by a complete set of PLANS that shall be designed by a Texas State Fire Marshal’s Office Fire Alarm Planning Superintendent certified designer who is licensed in the State of Texas and all submitted PLANS must be stamped by the licensed designer in accordance to the requirements of the Texas State Fire Marshal’s Office. The system design shall be in accordance with UL, NFPA, NEC, ANSI, and IEEE standards.
3. Furnishing a complete system installation responsibility which shall include the furnishing of all labor, materials, and items of service required for the completion of a functional fire alarm system for the Substation No. 1 Building and the Administration Building as reviewed by the Owner in strict accordance with this section of the specifications and the applicable contract drawings. At minimum, all aspects of the fire alarm system installation shall be directly performed by or under the direct supervision of a State of Texas Fire Marshall’s Office Fire Alarm Technician certified technician that is licensed in the State of Texas.
4. Furnish and install a complete and fully functional fire alarm system as shown on the PLANS and as Specified herein for the Substation No. 1 Building and the Administration Building. The fire alarm system shall utilize a complete, electrically supervised digital addressable, multiplexed signal transmission, intelligent type fire alarm control system.
5. Fire alarm control panel, remote annunciator panels, monitor panels, fire alarm pull stations, smoke and heat detectors, audible and visual notification appliances, addressable interface devices, device enclosures/back boxes, coverplates, interconnect conduit/wiring, mounting hardware, and all related incidentals for a complete and fully functional fire alarm system shall be furnished and installed. Boxes, conduit/wire shall be sized, furnished, and installed per the requirements of the PLANS and Division 16 Specifications unless specified otherwise herein.
6. All major elements of work are believed to be adequately described herein. The FASC is expected to anticipate and include in the cost of the work any incidentals which may be required, but not specifically expressed herein, in order to provide a complete and fully functional fire alarm system for the Substation No. 1 Building and the Administration Building.

7. The FASC shall provide a fire alarm system that meets all of the requirements stated herein. The FASC is expected to make allowances for all necessary adjustments for the actual installation and to examine physical conditions which may affect the performance of their work, and coordinate the actual pipe routing and equipment locations as necessary to accommodate the existing conditions, obstructions, and the work of other trades. No extra payment will be allowed for FASC's failure to make such allowances. The cost associated with this task shall be included in the FASC's base bid.
8. The omission by the Engineer of any necessary system component, as required by the Authorities Having Jurisdiction, in the Drawings, or Specifications shall not relieve the FASC of the responsibility for verifying and providing such necessity, without additional cost to the Owner.
9. The fire alarm system shall meet all current NFPA code requirements, including but not limited to NFPA 13, 13R, 13D, 14, and 72 and per the edition as required by the City of Austin. The fire alarm system shall meet all requirements of the City of Austin Fire Department, ADA guidelines, all applicable Texas Accessibility Standards, and currently adopted edition of the International Fire Code (IFC) as amended by the City of Austin.
10. The FASC shall be responsible for coordinating with AT&T and the Owner for the installation of telephone services to the Substation No. 1 Building and the Administration Building. The Owner shall furnish and install the telephone cables up to the Substation No. 1 Building and the Administration Building, the FASC shall be responsible for routing the telephone cables within the Substation No. 1 Building and the Administration Building and for the termination of the telephone cables to the Fire Alarm Control Panel.

B. System Description:
1. The fire alarm system shall monitor the smoke detectors and heat detectors for trouble and activation with audible and visual indication at the fire alarm control panel.
2. The fire alarm system shall be an addressable digital supervised system.
3. As part of the fire alarm control panel, furnish and install a digital alarm communicator transmitter to seize telephone line(s), dial preselected telephone number(s), transmit fire alarm, supervisory, and trouble signals to a remotely located digital alarm communicator receiver central alarm station (operated by the Authority Having Jurisdiction) over a telephone line(s).
4. The fire alarm control panel shall include interface capability with the fire suppression systems.
5. The fire alarm control panel shall provide signals as required to the security system to release all electrically locked exit doors on general alarm, where applicable.
6. The fire alarm control panel shall provide interface capability to smoke dampers, fans, air conditioning equipment, and other equipment as required for a fully functional and complete fire alarm system.
7. Provide a total coverage smoke-detection system in accordance with the fire code and interconnect the total coverage smoke-detection system with all air-moving equipment, as required per the Authority Having Jurisdiction, to accomplish the required shutoff of air-moving equipment without the need of duct-mounted smoke detectors.

1.02 RELATED REQUIREMENTS

A. Drawings and other Technical Specification Sections show and/or specify additional features required to describe and illustrate functional requirements of the fire alarm system.

B. FASC Qualifications:
   1. The fire alarm system design/installation entity shall have a minimum of five (5) years experience designing, furnishing, and installing complete fire alarm systems for buildings/facilities that are similar in scope and value as required for this project.
   2. FASC shall have current firm alarm certificate of registration issued by the State of Texas Fire Marshal's office and employ the licensed Fire Alarm Planning Superintendent and Fire Alarm Technician(s) who are performing the work on this project.

C. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those required for this project and with a record of successful in-service performance.

D. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system components from a single manufacturer where possible.

E. Comply with the applicable requirements of Division 16 Specifications.

F. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

G. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.03 COORDINATION.

A. Coordinate as required with all necessary utility service providers such as telephone (AT&T), Authorities Having Jurisdiction such as the City of Austin Fire Department, etc. as required to establish the complete functional fire alarm system required for the project as shown on the Drawings and as specified herein.

B. Coordinate layout and installation of fire alarm system subcomponents with other trades. Coordination with the overall construction sequencing of facility is required to meet the raceway routing and device mounting requirements of the Drawings and Specifications.

1.04 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:
   1. Riser diagram of fire alarm system, initiating devices, notification appliances and interface connections.

2. Layout drawings showing locations of devices and appliances, junction boxes, wire and conduit routing, auxiliary power supplies for visuals and connections to fire suppression system supervisory and ancillary devices.
3. Dimensioned/scaled top and bottom enclosure views, front enclosure elevations, and internal component/device layouts, as applicable
4. Wiring diagrams, as applicable,
5. Catalog cut sheets. Include all system sub-components, annunciator panel, as applicable.
6. Calculations: Include notification circuit voltage drop, control panel battery-sizing, and other calculations.
7. Certifications: Include the Alarm Planning Superintendent, Alarm Installation Technician, and Firm certifications/registrations with the State of Texas Fire Marshall's Office.

B. Field test reports: Indicate and interpret test results for compliance with performance requirements.

C. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals previously specified, make an identical submission to the City of Austin Fire Department. Include copies of annotated contract Drawings as needed to depict component locations to facilitate review. Resubmit as required to make clarifications or revisions to obtain approval. Upon receipt of comments from the Authorities Having Jurisdiction, submit to Engineer for review.

D. Certificate of Completion: Comply with NFPA.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:
1. Installation and operation manuals.
2. Renewal parts bulletin.
3. As built drawings, including approved shop drawings.
4. Test data
5. Record copy of site specific software on CD ROM, complete with all necessary files
6. Software licenses registered in the name of the Owner
7. Software and Firmware Operational Documentation:
   a. Software operating and upgrade manuals.
   b. Device address list.
   c. Printout of software application and graphic screens.

1.06 CODE REQUIREMENTS AND PERMITS

A. Code Requirements:
1. All aspects of the electrical construction shall comply with all National Electrical Code (NEC), NFPA, IEEE, OSHA requirements, local ordinances, the Authorities Having Jurisdiction, and all other pertinent codes and standards, latest revision.

1.07 SPECIAL SERVICES

A. Provide service and maintenance of fire alarm equipment for two years from date of Substantial Completion.

B. Software Service Agreement:
   1. Comply with UL 864
   2. Technical Support:
      a. Provide software support for two years from the date of Substantial Completion
   3. Upgrade Service:
      a. Update software to latest version at Project completion. Furnish, install, configure, and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software. Provide 30 day advance written notice to the Owner to allow for scheduling and access to the system. All upgrades shall also be provided to the Owner on CD-ROM, and a full backup of the existing (prior to the upgrade) system software and settings shall be made on CD-ROM and provided to the Owner prior to upgrade.

1.08 SPARE PARTS

A. Furnish ten percent spare parts or a minimum quantity of three, which ever is greater, for the following:
   1. Audio / visual signal units
   2. Smoke and heat detectors
   3. Manual pull stations
   4. Lamps for audio/visual signal units of each type
   5. Detector bases of each type
   6. Printer ribbons/cartridges
   7. Fuses of each type
   8. Keys and tools (minimum one set)

B. Furnish the above spare parts packaged with protective covering for storage and identified with labels describing the package contents.

PART 2 PRODUCTS

2.01 GENERAL

A. All products shall be U. L. Certified, at minimum.

B. Manufacturers:
   1. Grinnell Simplex
   2. Silent Knight,
   3. Federal Signal Corporation,
   4. Fire Control Instruments, Inc.
   5. Siemens Cerberus
   6. General Electric

7. or approved equal

2.02 SYSTEM OPERATIONAL DESCRIPTION

A. Furnish and install fire alarm signal initiation by the following:
   1. Manual stations
   2. Heat detectors
   3. Smoke detectors
   4. Duct smoke detectors
   5. Verified automatic operation of smoke detectors
   6. Automatic suppression system flow, as applicable
   7. Fire-extinguishing system operation
   8. Fire standpipe system
   9. other alarm inputs as provided by the Fire Suppression Systems, as applicable

B. Fire alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances
   2. Identify alarm at fire alarm control panel and applicable remote annunciator panels.
   3. Initiate digital alarm communicator transmitter and transmit an alarm signal to the remotely located digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.
   4. Unlock electric door locks in designated egress paths
   5. Release fire and smoke doors held open by magnetic door holders.
   6. Shutdown of fans and other air-handling equipment serving zone when alarm was initiated and as required per the requirements of the Authority Having Jurisdiction and at no additional cost to the Owner.
      a. Mechanical air-handling equipment, including, but not limited to, mechanical ventilation equipment, shall be supervised by the Fire Alarm System as required per the Authority Having Jurisdiction.
      b. Coordinate all final requirements with the Authority Having Jurisdiction prior to and at the time of shop drawing review/approval by the Authority Having Jurisdiction.
   7. Close smoke dampers in air ducts of designated air-conditioning duct systems serving zone where alarm was initiated.
   8. Record events in the system memory.
   9. Record events by the system printer.

C. Furnish and install fire alarm system supervisory signal initiation by the following:
   1. Valve supervisory switch
   2. Low air pressure switch for dry pipe or pre-action sprinkler system
   3. Other supervisory signals available from the fire suppression systems specified, if any
   4. Record events in the system memory.
   5. Record events by the system printer.
   6. Initiate the digital alarm communicator transmitter and transmit supervisory signals to a remote digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.

D. Furnish and install fire alarm system trouble signal initiation by the following:
   1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control panel
4. Ground or a single break in fire-alarm control panel internal circuits.
5. Abnormal ac voltage at fire-alarm control panel.
6. Failure in standby battery circuitry or battery charging.
7. Abnormal position of any switch at fire-alarm control panel or annunciator.
8. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system
9. Other trouble signals available from the fire suppression systems specified, if any.
10. Record events in the system memory.
11. Record events by the system printer.
12. Initiate the digital alarm communicator transmitter and transmit trouble signals to a remote digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.

2.03 FIRE ALARM CONTROL PANEL

A. Construction: Enclosed panel, NEMA 12 rated at minimum, suitable for wall surface mounting and the application environment in which the panel is located. Also refer to the Drawings. Provide multiple enclosures as required to contain the components as specified.

B. Power Supply:
1. Primary Power Input: 120 volts, AC, 60 Hertz, single phase, single point feed.
2. Derive the necessary power for all fire alarm system sub-component loads from the single point feed inclusive of all needed power supplies, voltage transformation, and all necessary short circuit and overload protection for a fully functional system.

3. Secondary Power Input: 24 volts DC supply system with batteries, automatic battery charger, and automatic transfer switch, complete with all accessories, furnished and installed integral to the panel. Batteries shall be sealed valve regulated recombinant lead acid type. Batteries shall be sized to operate the complete system under the following operating scenario: 24 hours with the complete system operating in normal or supervisory (non-alarm) operating mode followed by an additional 10 minutes with the complete system operating in alarm or supervisory mode (including all notification appliances).
4. Fire alarm system loads shall automatically transfer to the secondary power input upon loss of the primary power input.
5. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

C. General Requirements:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
2. System software and programs shall be stored in non-volatile programmable memory, retaining the information through failure of primary and secondary power supplies.
3. Include a real-time clock for time annotation of events on the event recorder and printer.

4. The System shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. Separate alarm, supervisory, and trouble logs shall be provided.
5. Provisions for addressable initiation devices that communicate device identity and status with the following:
    a. Smoke sensors shall additionally communicate sensitivity setting
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device
    c. Addressable control circuits for operation of mechanical equipment
    d. other devices as required
6. All wiring and terminal blocks shall be tagged.
7. Provide overall three ply phenolic red-white-red nameplate with lettering not less than 1 inch high for control panel. Secure to enclosure with stainless steel screws.

D. Indication and System Controls:
    1. Alpha-numeric Indication:
        a. Arranged for interface between human operator at fire-alarm control panel and addressable system components including annunciation, supervision, and control. Display alarm, supervisory, and component status messages and the programming and control menu
        b. Type: Liquid-crystal type, 80 character minimum
    2. Keypad: Arranged to permit entry and execution of programming, display, and control commands
    3. Discrete Indicating Lights and System Controls:
        a. At a minimum, provide individual LEDs identifying alarm and trouble conditions within each zone and the type of device originating the signal.
        b. At a minimum, provide system reset, alarm acknowledge, alarm silence, system test, and lamp test pushbuttons. These may be integrated into the keypad at the manufacturer's discretion.

E. Serial Interfaces: Minimum of two RS-232 or Universal Serial Bus (USB) ports to provide connections to printers, laptop computers, and miscellaneous peripheral devices. USB ports are preferred if available.

F. Input/Output Signals: Furnish and install the quantity and rating of input/output signals as required to interface with the Fire Suppression Systems, Smoke Dampers, door locks, air conditioners, fans, and other equipment as specified elsewhere and as shown on the Drawings for a complete and functional system at no additional cost to the Owner.

G. Digital Alarm Communicator Transmitter:
    1. Furnish and install a digital alarm communicator transmitter to automatically transmit alarm, supervisory, and trouble signals to a remote digital alarm communicator receiver central alarm station operated by the Authority Having Jurisdiction.
    2. Digital alarm communicator transmitter shall be acceptable to the remote digital alarm communicator receiver central alarm station and shall comply with UL 632. Coordinate requirements with the Authority Having Jurisdiction.
    3. Digital alarm communicator transmitter shall be mounted integral to the Fire Alarm Control Panel.

4. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control panel and automatically captures one or two telephone line(s) and dials a preset number for a remote digital alarm communicator receiver central alarm station(s). When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote digital alarm communicator receiver central alarm station over the remaining line. Transmitter shall automatically report telephone service restoration to the remote digital alarm communicator receiver central alarm station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal. Transmitter shall be field programmable for use with one or two telephone lines.
5. Self-Test: Conducted automatically every 24 hours with report transmitted to remote digital alarm communicator receiver central alarm station.
6. Digital alarm communicator transmitter shall also provide
    a. LED display
    b. Field programmable selection of signals to be transmitted to the remote digital alarm communicator receiver central alarm station
    c. Programming device.

H. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events. Printer shall be furnished and installed integral with the fire alarm control panel.

I. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

J. The Fire Alarm Control Panel shall be manufactured by Tyco SimplexGrinnell, and no equal.

K. The Fire Alarm Control Panel shall Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".

L. The following Fire Alarm Control Panel hardware shall be provided:
1. Power Limited base panel with platinum cabinet and door, 120 VAC input power.
2. Minimum 2,500 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. Minimum 2000 points of annunciation where one (1) point of annunciation equals:
    a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
    b. 1 LED on panel or 1 switch on panel.

4. 9 Amp Power Supply minimum with temperature compensated, dual-rate battery charger capable of charging up to 110 Ah batteries without a separate external battery charger. Battery charger voltage and amperage values shall be accessible on the Fire Alarm Control Panel LCD display.
5. Minimum One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
6. Minimum One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
7. Minimum Three (3) Class B Addressable Notification Appliance Signaling Line Circuits (SLCs).
    a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 127 Notification Appliances per channel.
    b. Wiring shall be 16 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.
    c. A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the Fire Alarm Control Panel to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.
    d. For systems that do not provide a constant voltage source at the Fire Alarm Control Panel notification appliance field wiring terminal connections, the fire alarm contractor shall:
        1) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and
        2) Perform a complete functional test of all notification appliances under worst case secondary power conditions.
8. Minimum Three (3) Class B Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
    a. NAC's shall be conventional reverse polarity operation and shall be for synchronized strobes and independent horn/strobe operation over two wires.
    b. NACs shall be selectable as auxiliary power outputs derated to 2 A for continuous duty.
    c. Strobe synchronization and audible cadence synchronization shall be across all panel NAC circuits. Systems that cannot provide listed synchronization across all panel NAC's shall not be acceptable.
9. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
10. Expansion Power Supplies with minimum three (3) Class B integral Intelligent Addressable Notification Appliance Signaling Line Circuits (SLCs) for system expansion. Expansion power supplys shall provide complete capability as the primary power supply.
11. Power Supplies with integral conventional reverse polarity Notification Appliance Circuit Class B for system expansion. Expansion power supplys shall provide complete capability as the primary power supply.
12. Minimum Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 10A @ 250VAC, resistive), operation shall be programmable for other fire response functions. Relays shall be capable of switching up to 10 A @ 250VAC, inductive.

13. The Fire Alarm Control Panel shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.
14. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
15. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.
16. Programmable DACT for either Common Event Reporting or per Point Reporting.
17. Fire Panel Internet Interface to provide supplemental notification and remote user access to the Fire Alarm Control Panel using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3.
18. Modular Network Communications Card.

M. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

N. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
1. The system shall have the capability to provide expanded content, multi-line, operator interface displays as indicated on the drawings and specifications. The expanded content multi-line displays shall be Quarter-VGA (QVGA) or larger and be capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA operator interface shall provide operator prompts and six context sensitive soft-keys for intuitive operation.
    a. Expanded content, multi-line operator interfaces shall be capable of providing the following functions:
        1) Dual language operation with Instant-Switch language selection during runtime.
        2) Activity display choices for:
            a) First 8 Events.
            b) First 5 Events and Most Recent Event (with first and most recent event time and date stamps).
            c) First Event and Most Recent Event (with first and most recent event time and date stamps).
            d) Scrollable List Display displays a scrollable list of active points for the event category (alarm, priority 2, supervisory, or trouble) selected. The position in this list will be the last acknowledged point (not flashing) at the top followed by the next 7 unacknowledged points (flashing).
            e) General Event Status (alarm, priority 2, supervisory, or trouble in system)
            f) Site Plan
        3) Equal or hierarchal priority assignment. In systems with two or more operator interfaces, each operator interface shall be programmable

to allow multiple operator interfaces to have equal operation priority or to allow hierarchal priority control to be assigned to individual operator interfaces (locations).

4) Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.

5) Bitmap file import for operator interface display of site plan and background watermark images.

2. Expanded content, multi-line displays shall have the capability to provide Dual-Language operation.
   a. Language selection shall be via a switch on the operator interface panel. Operator interface panels shall support instant-language-switchover during runtime to allow the operator to toggle between languages each time the language selection switch is operated, without requiring complicated multi-step processes.
   b. Both one-byte and two-byte characters shall be supported.

O. Distributed Module Operation: File Alarm Control Panel shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel (SLC):
   1. Addressable Signaling Line Circuits
   2. Initiating Device Circuits
   3. Notification Appliance Circuits
   4. Auxiliary Control Circuits
   5. Graphic Annunciator LED/Switch Control Modules
      a. In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.
   6. Amplifiers, voice and telephone control circuits

2.04 MANUAL PULL STATIONS

A. General:
   1. Fabricated of metal or plastic and finished in red with molded, raised-letter operating instructions in contrasting color.
   2. The Manual Pull Station shall be surface mounted. Furnish and install manufacturer's surface back box. Furnish and install coverplate.
   3. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type.
   4. Integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control panel.

2.05 SMOKE DETECTORS

A. General:
   1. Operating voltage: 24 volts DC
   2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated
6. Field adjustable: Detector can be adjusted and tested after installation

B. Photoelectric Smoke Detector:
1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. LED or infrared light source suitable for use as a smoke detector and tested per UL 268A.

C. Ionization Smoke Detector:
1. Shall respond to both visible and invisible combustion products.

2.06 HEAT DETECTORS

A. Heat Detector, Combination Type
1. Actuated by either a fixed temperature of 135 degrees F or rate of rise that exceeds 15 degrees F per minute
2. Mounting: Adapter plate for outlet box mounting
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

B. Heat Detector, Fixed Temperature Type:
1. Actuated by either a fixed temperature of 135 degrees F or rate of rise that exceeds 15 degrees F per minute
2. Mounting: Adapter plate for outlet box mounting
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.

2.07 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances:
1. Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
2. Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
3. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
4. Mounted on recessed outlet box. Where surface mounted, furnish and install manufacturer's surface back box. Furnish and install coverplate.

B. Horns: Electric-vibrating-polarized type, 24 volts DC; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 85 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens. Provide rated light output in accordance with the requirements of the Authority Having Jurisdiction.

2.08 REMOTE ANNUNCIATOR PANEL

A. General: Provide annunciator panel where required by the Drawings or by the Authorities Having Jurisdiction.

B. Description: Annunciator functions shall match those of fire-alarm control panel for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control panel, including acknowledging, silencing, resetting, and testing.

C. Construction: Enclosed panel, NEMA 3R rated at minimum, suitable for wall surface mounting and the application environment in which the panel is located. Also refer to the Drawings.

D. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control panel. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

E. Provide overall three ply phenolic red-white-red nameplate with lettering not less than 1 inch high for each annunciator panel. Secure to enclosure with stainless steel screws.

2.09 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module for use in providing a system address for alarm-initiating devices with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to/from equipment as required by the Drawings and Specifications for a complete functional system.

2.10 MISCELLANEOUS

A. Wiring:
   1. Non-Power-Limited Circuits: Furnish and install wiring per Section 16200 “Wiring (600 Volts and Below)”. Exception: The following minimum wire sizes apply:
      a. Low voltage circuits: No. 16 AWG, minimum
      b. Line-Voltage circuits: No. 12 AWG minimum.
   2. Power-Limited Circuits: Furnish and install NFPA 70, Types FPL, FPLR, or FPLP as recommended by the manufacturer. Minimum wire size is No. 16 AWG

B. Building Maps and Signage:
   1. Building map shall be provided adjacent to the Fire Alarm Control Panel and each annunciator panel. Map shall consist of floor plans with all room

numbers and zones identified. Maps shall be properly oriented and mounted in a durable frame. Handwritten or hand-drawn maps shall not be accepted.

2. Provide additional signage as required by NFPA and Authorities Having Jurisdiction at no additional cost to the Owner.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Equipment Mounting: Install fire-alarm control panel with tops of cabinets not more than 72 inches above the finished floor.

B. Manual Pull Stations: Mount in back boxes at 48 inches above finished floor.

C. Smoke- or Heat-Detector Spacing: Comply with NFPA

D. Visible/Audible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and not more than 80 inches above the floor or least 6 inches below the ceiling, whichever is lower.

E. Although it may not be shown on the Drawings, size, furnish, and install conduit/wire to interconnect the Fire Alarm Control Panel to the Building Telephone System.

3.02 GENERAL INSTALLATION

A. Furnish and install all wiring complete in a raceway system per all applicable requirements of the Division 16 specifications and the Contract Drawings, with the following supplementary requirements:
   1. Color code all wiring differently from that used for normal building power wiring. Use different wiring colors for alarm and supervisory wiring
   2. Paint fire alarm system junction/pull boxes red
   3. Ground fire-alarm control panel and associated circuits and comply with IEEE 1100.

3.03 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by the Owner and the Authorities Having Jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, for all tests.

C. Perform the following tests and inspections:
   1. Pre-Test:
      a. After installation, align, adjust, calibrate, and balance the system and perform complete pre-testing.
      b. Test audible and visual appliances, smoke detectors, and heat detectors according to manufacturer's written instructions.
      c. Test for proper function of automatic transfer between primary and secondary power sources.
      d. Test battery charging and battery backup system.

e. Test interlocks between the fire alarm system and:
    1) Fire suppression systems, as applicable
    2) elevators, as applicable
    3) door locks, as applicable,
    4) supervisory valves,
    5) annunciator panels,
    6) and other equipment
f. Test for functional compliance with the Contract Requirements. Correct deficiencies observed, replace malfunctioning components as required, and perform all necessary adjustments re-testing until satisfactory performance is achieved.
g. Maintain a log of testing and associated test results for the Owner's review.

2. Final Test:
    a. Provide minimum of 14 days written notice to the Owner when the system is ready for final acceptance testing.
    b. Test system per the requirements of NFPA and the Authority Having Jurisdiction.
    c. Correct all deficiencies and completely re-test work affected.
    d. Provide a typewritten report of test results signed by the Technician and witnesses.
    e. Provide Certificate of Completion per NFPA.
3. After installation and final testing, clean and vacuum all interior of the equipment. Touch-up and restore damaged surfaces to factory finish.

3.04 TRAINING

A. Engage a factory-authorized service representative for a period of not less than one (1) eight hour working day for the purpose of training the OWNER's personnel to adjust, operate, and maintain the Fire Alarm System. Training shall also include topics on software related upgrades and maintenance. The total training duration shall be subdivided into two (2) equal-time sessions in which the training curriculum/material of each session shall cover all of the specified and installed Fire Alarm System and the same training curriculum/material shall be covered during each session. The training sessions may take place on the same day or on different days as selected/scheduled by the OWNER. Provide the training at the OWNER's designated facility located in Austin, Texas. The date of this training shall be scheduled with the OWNER, but will be after the entire Fire Alarm System is in operation. Include all associated expenses.

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 14555

SHAFTLESS SCREW CONVEYOR AND APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install shaftless screw conveyor(s) as shown on PLANS and as specified herein for the receiving and conveyance of municipal screenings material removed by mechanical bar screens. Each unit to consist of spiral flighting, trough, chutes, covers, supports, drive motor, anchor bolts, associated controls and all accessories and appurtenances required for a complete and properly operating installation.

B. Test shaftless screw conveyor gear reducers, motors, controls and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A36/A36M: Standard Specification for Carbon Structural Steel
   2. A48: Specification for Gray Iron Castings.

B. American National Standards Institute (ANSI):
   1. B20.1: Safety Standards for Conveyors and Related Equipment.
   2. S1.11: Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets.

C. National Electrical Manufacturers Association (NEMA):
   1. MG1: Motors and Generators.

D. D4020. Ultra-High Molecular Weight (UHMW) Polyethylene Molding and Extrusion Materials

E. National Electrical Code (NEC) - Class I, Group D

F. National Electrical Manufacturer’s Association (NEMA) - Design C.

G. Operations Safety and Health Association (OSHA).

H. Conveyor Equipment Manufacturer’s Association (CEMA), except where exceeded by this Section, which will take precedence

I. Society of Automotive Engineers (SAE) – 4140.

1.03 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01300:
   1. Certified shop and erection drawings showing important details of construction including dimensions, anchor bolt locations, and field connections. General

arrangement drawings, plan and section showing conveyors, gate, chutes, supports and all process equipment interfaces. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified.

2. Descriptive literature, bulletins, and catalogs of the equipment, including details of the motor, gear reducer, and lubrication points. Data regarding equipment performance and motor characteristics and performance.
3. Drawings showing materials of construction, thicknesses, operating and maintenance envelope and assembly weight.
4. Spiral strength calculations using Mark's Handbook calculation for spring (spiral) compression and elongation showing the supplied spiral meets or exceeds spring effect intent specified herein.
5. Bearing life calculations for the gear reducer bearing and or drive end bearings.
6. Design loading calculations to be transmitted to foundation or supports.
7. Installation, operation, and start-up procedures. Equipment weight and lifting points for installation and removal purposes.
8. Motor manufacturer's data sheets and drawings. Motor shop test results.
9. Schematic control and power wiring diagrams including interconnecting and internal wiring diagrams.
10. Control panel drawings.

B. Furnish in accordance with Section 01730:
   1. Operating and maintenance instructions and parts lists. A list of recommended spare parts other than those specified. Predicted life of parts subject to wear.

C. Installation Report:
   1. Furnish copies of certified report prepared by Manufacturer's technical representative certifying satisfactory installation, operation, and in service placement of units.

1.04 SPARE PARTS

A. Provide spare parts that are identical to and interchangeable with similar parts installed.
   1. Furnish following spare parts:
      a. One set of all special tools required.
      b. One set of shaft seals per conveyor
      c. One full set of preformed liner material

1.05 QUALITY ASSURANCE

A. Comply with the requirements specified in Specification Section 1400, "Quality Control Services".

B. Equipment specified shall be the product of a single manufacturer.

C. The Contractor shall obtain the shaftless screws, troughs, covers, supports, chutes, gates controls, gear reducers, motors and appurtenances from the shaftless screw conveyor manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system. Contractor responsible

for all details necessary to properly install, adjust, and place in operation complete working system.

D. Equipment specified shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

E. Conveyor will be fully assembled and run tested to confirm fit and function of the conveyor. A certificate of the shop run test shall be supplied with the shipping documents.

F. Manufacturer of specified equipment shall have a minimum of five (5) operating installations with equipment of the size specified and in the same service as specified operating for not less than five (5) years.

G. If equipment proposed is heavier or taller, different width, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

H. Provide fabrication in compliance with all applicable ASTM standards or equivalent international standards.

1.06 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver to site undamaged.

B. Storage: Store above ground on platforms, skids, or other supports, and protect from corrosion and mechanical damage in accordance with manufacturer's recommendations and instruction. Protect electrical components from condensation.

C. Handling: Handle unit to prevent damage during unloading and installation. Follow manufacturer's instructions on lifting and setting.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Conveyor system capacities and operating data are indicated in Attachment "A Conveyor Schedule" to this Specification Section.

B. Conveyor system includes but is not limited to motor, drive, u-trough, shaftless screw, covers, chutes, gates, drain, controls, control panel, structural steel supports, and appurtenances, as specified and indicated, and will provide a complete and ready to operate system.

C. Interface
1. Coordinate collection points with the discharge of the process equipment so that the conveyor properly receives material to be conveyed.
2. Coordinate conveyor discharge chutes and gates with the collection container.
3. Coordinate wash water connections and drain connections.
4. Coordinate support locations with the process equipment to avoid conflicts.

D. Performance:
   1. Conveying equipment to transport municipal screenings from the process equipment as indicated and specified.
   2. Conveying equipment shall be capable of handling capacity range as specified and indicated.

2.02 MANUFACTURERS

A. JDV Equipment

B. Vulcan Industries

C. SPIRAC

2.03 SHAFTLESS SCREW CONVEYOR CONSTRUCTION

A. General
   1. Provide shaftless screw conveying system as specified and indicated. Provide conveyors designed specifically for transport of screening material received from the mechanical bar screens. The screw conveyor shall be designed to convey screenings from the drive end of the unit to the discharge end. Provide conveyors complete with appurtenances and accessories as specified and as necessary to continuously convey materials automatically.
      a. Conveyors with shafted spirals are not acceptable.
      b. Conveyor designs developed for free flowing bulk material are not acceptable.
   2. Provide screw conveyors able to operate continuously at the specified operating conditions and also able to start and operate with a full trough.
   3. Provide each screw conveyor with the following:
      a. A minimum of 1-1/2-inch freeboard between the top of the screw flight and the underside of the trough cover.
      b. Stub shafts: Flanged and bolted to mating flanges of the conveyors spiral rotor or coupling disc and shall incorporate register fits.
      c. Provide the rotating speed of the screw selected to match the pitch, diameter, trough fill, and screenings transport characteristics.
      d. Provide each conveyor equipped with torque overload and motor overload protection.

B. Inlet Hopper
   1. The inlet hopper shall be provided by the conveyor supplier as shown on the PLANS. The inlet zone will be completely shrouded to contain the screenings. All the hardware shall be fabricated from the same material as the conveyor trough.

C. Screw Conveyor Troughs and Casings
   1. Trough
      a. U-shaped and similar to the dimensional standards of CEMA 350 and enclosure classification IIE.
      b. Provide shaftless spiral screw conveyor trough fabricated of minimum 1/8-inch thick Type 304L stainless steel. Provide troughs with an integral (welded or bolted connection), minimum 3/8-inch thick Type 304L stainless steel end plate and drive support base of all welded construction onto which the conveyor drive assembly is mounted. The end plate of the

last segment of each screw conveyor trough shall consist of a welded minimum 10 mm thick Type 304L stainless steel plate of the full cross-section of the trough, and its segment mating flanges.

c. Provide trough segments consisting of rolled sections butt welded together to give a maximum single segment of not more than 20 feet in length. Provide trough end flanges roll formed Type 304L stainless steel bar welded to the ends of the trough segments. Locate bolt holes for connecting trough sections together on the centerline of the roll formed flanged within a tolerance of plus or minus 0.02 inches of the theoretical radius centerline and at a distance of not greater than 0.02 inches. Provide bolt holes uniformly located on either side of the trough's vertical section centerline. Apply compressible "flow type string" gasket material to flanged faces to give a sealed joint when trough segments are bolted together.

d. Provide the trough body roll formed to a uniform radius (or diameter) within a tolerance of plus-or-minus 1/8-inch. Provide the trough with double U-shape or L-shape flanges formed by a break press as an integral part of the rolled trough body. Separate welded flanges are not acceptable.

e. The maximum length of any preassembled section of trough: 20-feet and no more than two separate segments bolted together in any preassembly shipped to site. Site welding is not acceptable.

f. Provide a trough stiffener channel bolted across the width of the trough made of Type 304L stainless steel. Set stiffener channel spacing to match cover edges to give a sealed face upon which the covers are bolted.

2. Trough Liner

a. Provide troughs fitted with a liner manufactured from ultra-high molecular weight polyethylene, not less than 1/2-inch thick formed and bonded with two layers each a different color.

1) The liner shall meet the following requirements:

a) Density: 61.2 lbs/ft3

b) Shore Hardness, D: 64

c) Ball Indent Hardness: 5946 psi

d) Crystalline Melting Range: 278 degree F

e) Dynamic Coefficient of Friction: 0.1-0.12 ratio of tension/load

f) Molecular Weight: $9.2x10^6$ g/mol

2) Liner Length:

a) 4.0-foot maximum sections.

3) Provide liner held in place with Type 304 stainless steel clips. No fasteners are accepted.

b. Refer to Paragraph 2.03.F.1.b for Warranty requirement if one color liner is used.

3. Covers: Provide bolted covers for any portion of each trough that is not covered by the filling chute.

a. Provide covers manufactured in maximum 5.0 foot lengths, minimum thickness 1/8-inch to allow for easy access and ease of liner replacement.

b. To prevent unsafe access to the conveyors, quick opening covers are not acceptable unless they are also bolted to prevent access during operation. Covers to have handles and gasket seals.

c. Provide each conveyor with the appropriate warning labels to call for lock out – tag out of the electrical system before the covers are removed. If

inspection of the system during operation is required, provide an inspection hatch with finger guards.

d. Provide lockable inspection hatches over drop chutes with 304 SS safety mesh.

4. Supports
   a. Provide separate supports at the inlet and discharge end, with intermediate supports as required. The intermediate supports shall be not less than one for every 10 feet of length of trough segment. Provide supports in Type 304L stainless steel with its flat face rolled to match the trough shape and extending around the entire trough circumference up to within 2 inch of the top face of the trough U-flange.
   b. Coordinate conveyor support with the screen channel locations so as to avoid conflicts with installation of the screening equipment. Coordinate location of support legs axially along the trough to avoid conflict with other equipment.
   c. Support spacing across the trough: Not to exceed 2.5 feet from center to center of support leg.
      1) No supports shall be installed in location of instrument floor boxes or interfere with removal and placement of stop logs and covers.
5. Connections
   a. Provide a flanged drain outlet with each conveyor to facilitate cleaning.
      1) Provide the drains pipes as indicated and specified.
      2) Provide drain flushing connections as indicated and specified.
   b. Provide each trough equipped with inlet and/or discharge openings as indicated.
      1) Where the inlet and discharge openings connect to another device provide suitable flanged connections.
      2) Provide all interconnecting devices such as chutes and hoppers fabricated from the same grade of material as the troughs.
   c. Provide a 3-inch flanged drain connection on conveyor troughs as indicated.

D. Screw Conveyor Flights
1. Provide spiral flighting for the shaftless screw conveyors designed to convey material without a center shaft or hanger bearings.
2. Spiral flights:
   a. Cold-formed high strength chrome alloy steel with a minimum hardness of 220 Brinnell.
   b. Provide the spiral flights designed to prevent distortion and jumping in the trough.
   c. Provide a second, inner spiral, concentric with the outside spiral.
   d. Provide the flights design so that the torsional rating of the auger flighting exceeds the torque rating of the drive motor at 150 percent of its nameplate horsepower.
   e. Spring effect of the spiral: Not to exceed 0.12 inches per foot of length at maximum load conditions.
   f. Maximum outer spiral thickness: 0.75 inches for spiral diameters up to 9 inches and 1 inch for spirals diameters greater than 9 inches.
   g. Provide the spiral flighting formed in sections from one continuous flat bar and concentric to within plus-or-minus 5/64 inch.
   h. Sectional flighting formed from plate is not acceptable.
   i. Provide spiral flighting with full penetration welds at all splice connections.

j. Align the flights to assure true alignment when assembled in the field.
k. Couple the spiral flights to the end shaft by a flanged, bolted connection.
l. Field welds at the jobsite by the Contractor for installation may be necessary when any overall conveyor length presents shipping or handling constraints. If this is the case the manufacturer will provide supervision and inspection of the welds.
m. Provide a gland packing ring to seal the drive shaft where it penetrates through the end plate, along with a sealing system.
n. Provide the connection of the spiral to the drive system through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral.
o. Provide the drive shaft with a mating flange bolted to the spiral connection plate. Provide a grease lubricated labyrinth seal shaft mounted internally in the conveyor between the back plate and spiral coupling connection.

E. Discharge Chutes & Slide Gates
1. Provide troughs with discharge chutes and slide gates for conveyance of screening material to the washing press and/or disposal containers. Provide at the locations indicated. Provide chutes with flanged ends. Provide transition with a rubber expansion joint.
a. Contractor shall provide coordination of chutes with the wash press collection hoppers as specified in Specification Section 11333, “Screenings Washer Compactor”.
2. Provide single-ply flanged discharge chutes at locations as indicated.
a. Flexible chutes: EPDM rubber hose, neoprene, Linatrile by Linatex Corporation, or acceptable equivalent product.
3. Slide Gates
a. Provide slide gates where indicated. Each slide gate shall be electro mechanically operated.
b. Provide slide gates designed with the following performance:
1) Maximum vertical dimension of 4 inches excluding the electric motor operator.
2) With the gate in the full, open position at least one pitch rotation of the spiral is exposed to the opening in the direction of transport and where layout permits 1.5 x spiral pitch opening.
3) Gate Opening: At least the full width of the conveyor trough.
c. Materials: Type 304/304L stainless steel with UHMW PE components, all minimum 3/16-inch thick. Provide UHMW PE with a machined groove to accept the gate blade and give a positive seal.
d. Provide electric actuators in accordance with Specification Section 13447, “Electric Actuators”. Provide the actuators supported underneath the conveyor trough by supports designed and supplied by the conveyor manufacturer.

F. Warranty:
1. The shaftless screw liner and spiral shall be warranted for a period of one year from the date placed in service.
a. Liner: For a wear indicator (two color) liner, excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30 percent of the conveyor length during the first three years of service. If these wear indications occur the conveyor supplier shall

provide new formed and banded liner to replace all the liner in the conveyor that has excessive wear.

b. If a one color liner is used, the excessive wear shall be indicated if the thickness of the liner, at three points over a 30 percent long section of the conveyor, is a 1/4-inch thick or less at the thinnest point of the liner, during the first three years of service. Since one color liners prohibit a simple visual inspection confirmation for the liner thickness status at the spiral-liner contact point, the conveyor manufacturer shall supply a field technician to the jobsite on the annual acceptance date for three consecutive years, to remove a minimum 30 percent of all liners and demonstrate to the Owner that at a minimum of 1/4-inch of liner is remaining. If excessive liner wear is found the conveyor supplier shall provide new formed and banded liner to replace all the liner in the conveyor that has excessive wear.

c. Screw: Excessive wear on the screw shall be indicated by loss of more than 50 percent of the height of the main outer screw section over 30 percent of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw to replace the screw in the conveyor that has excessive wear.

2.04 SAFETY DEVICES

A. Comply with ANSI B20.1 Standard, and include the following:
   1. Audible alarm, to sound for 30 seconds before conveyor starts and whenever emergency stopped.

B. Provide a zero-speed sensing device as an input to the plant SCADA to alarm when motor is running but conveyor is not.
   1. Enclosures NEMA 4X Type 304L stainless steel.

C. Emergency safety pull cable for each side of every conveyor.

2.05 CONTROLS

A. Provide the panel factory wired with all appurtenances for a complete operating system as specified and indicated.

B. Main Control Panel
   1. Contractor to furnish and install a dedicated packaged control panel for screw conveyor equipment. Control panel shall be contained in NEMA 4X stainless steel enclosure. Control panel shall include equipment controls, starters, and MCC. Location of main control panel as shown on Electrical and Instrumentation & Control Drawings. Control panel shall be provided in accordance with Specification Section 13390, "Packaged Control Systems".
   2. Design: Factory-wired and tested control panel designed to function with equipment. For each individual item, control panel functions as defined on the Electrical and Instrumentation & Control Drawings.
   3. Panels materials and design to be specifically selected for durability and corrosion resistance, for unprotected installation outdoors in presence of intense sunlight and corrosive gases (hydrogen sulfide).
   4. Panel shall be designed to meet all NFPA 820 area classification requirements. The upper level of the Headworks is classified Class 1,

Division 2. Panel shall be provided that satisfies all classification requirements.

5. Provide combination reversing starters in accordance with Specification Section 16444, “Combination Motor Starter”.

C. Field Control Station
   1. Contractor to furnish and provide field control stations for each item of equipment as defined on the Electrical and Instrumentation & Control Drawings.
   2. Field control station shall be per Specification Section 16540, "Field Control Stations".

2.06 OPERATION

A. Automatically start conveyors on momentary contact type remote start signal.
   1. Start conveyor on start of any upstream equipment feeding the conveyor.

B. Automatically stop conveyor 120 seconds after shutdown of all upstream feed process equipment.

C. Shutdown all upstream feed process equipment on conveyor stop.

D. Times to be field adjustable from 0 to 15 minutes.

2.07 CONVEYOR DRIVE SYSTEMS

A. Motor:
   1. Provide in accordance with Specification Section 16222, “Electric Motors, Induction, 600 Volts and Below” and as specified and indicated.
   2. Horsepower rating of motors: Not less than maximum brake horsepower requirements of equipment under any condition of operation specified and indicated without operating in the motor service factor.
   3. Motor enclosure and motor speed: As indicated in the conveyor Equipment Schedule.
   4. In addition to the requirements for bearings specified under Specification Section 16222, “Electric Motors, Induction, 600 Volts and Below”, provide motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.
   5. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet from motor.
   6. Operate without overheating at the speeds specified and indicated.
   7. Service Factor: 1.15.
   8. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.
   9. Rating: 460 V, 3-phase, 60 Hertz.
   10. Insulation: Class F with Class B temperature rise, 40 degrees C ambient.
   11. Site Altitude: Less than 3,300 feet above sea level.
   12. Provide capacity sufficient to start and operate conveyor 50 percent full without exceeding nameplate ratings for current and power and without operating in the service factor.

13. Provide drive units, including the reduction gearbox, shaft-mounted and positioned to facilitate maintenance work. Direct coupling of gear reducer/motor drive unit to the end flange of the conveyor will not be acceptable.

B. Gear Reducer:
   1. Provide parallel shaft arrangement classified for continuous, AGMA Class II, 24 hour duty.
   2. Provide ASTM A48 Class 30 cast iron housing.
   3. Gears: Case hardened alloy steel forgings with precision ground gear teeth minimum AGMA quality 12.
   4. Provide horizontal parallel or bevel right angle shafting, arrangement or as indicated in the Conveyor Schedule.
   5. Design reducer to match output speed requirements of screens.
   6. Match torque-rating of driven equipment.
   7. Gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

2.08 SHOP PAINTING

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Specification Section 09960, “High Performance Coatings”.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

D. Stainless steel surfaces do not require painting.

PART 3 EXECUTION

3.01 SHOP TESTING

A. The shaftless screw conveyor shall be factory assembled and factory run tested along with the main control panel.

3.02 INSTALLATION

A. Install items in accordance with shop drawings with no exceptions noted, manufacturer's printed instructions and as indicated.

B. After alignment is correct, grout using high grade non-shrink grout.
   1. Do not imbed leveling nuts in grout.

3.03 FIELD TESTING

A. Testing and Placing in Service

1. All final adjustments of equipment, controls, and instruments to be performed with assistance from technicians representing equipment manufacturer.
2. Coordinate start-up with other phases of construction for project. Instruct operating personnel concerning operating and maintenance procedures.

B. Manufacturer's Services
   1. Manufacturer's technical representative to assist in the following services:
      a. Checking installation of units.
      b. Testing and adjustment of screen mechanism.
      c. Instruction of OWNER's personnel in the operation and maintenance of screens.

C. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, and a completed and signed pre-testing check list.

D. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct a dry running test and a performance test for each unit in presence of the Engineer to determine its ability to deliver its rated capacity under specified conditions.
   1. Repeat tests until specified results are obtained.

E. Make all adjustments necessary to place equipment in specified working order at time of above tests.

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

ATTACHMENT "A"

CONVEYOR SCHEDULE

Parameters	Requirements
Number of Conveyors	1
Unit(s) Designation:	HW-CONVEYOR-01
Material Conveyed	Municipal Screenings
Average Density, lbs/ft3	65
Maximum Trough Fill Rate @ Design capacity, percent	100
Maximum Degree Inclined	0 (Horizontal)
Length, ft	See drawings
Discharge Configuration	Vertical
Conveyor Capacity, cf/hr	155
Inlet Quantity	2
Outlet Quantity	2
Nominal Trough Width, in	12.5
Minimum Screw Diameter, in	12
Maximum Screw Speed, rpm	20
Minimum spiral Weight per ft	27
Motor HP (minimum)	2
Drive Location	Inlet End
Motor Enclosure	TEFC
Reversing Screw	None

END OF SECTION

SECTION 14650

JIB CRANES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Jib cranes with trolley hoist.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. Manual of Steel Construction: Allowable Stress Design.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures and Section 15050 - Common Work Results for Mechanical Equipment.

B. Product data.

C. Shop drawings and calculations.

D. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

E. Project closeout documents:
   1. Provide vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Manuals.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Manufacturers: One of the following:
   1. GORBEL, Model FS300 – Foundationless; or equal

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Jib crane and hoist load capacity: 2,000 pounds.

B. Boom span: 8'-0" feet from centerline of base.

C. Trolley travel: 6’-3” (minimum)

D. Minimum clearance under boom: 9’-0” feet.

2.03 JIB CRANE

A. Design jib crane in accordance with AISC Specifications and Codes of the Manual of Steel Construction: Allowable Stress Design.

B. Jib crane shall be foundationless design, capable of being anchored into the mezzanine deck of Administration Building, as shown on 90S02, without additional concrete pad.

C. The boom deflection shall be limited to allow safe and easy hoist travel.

D. The bottom roller assembly shall be adjustable for leveling the boom.

E. Provide limit stops on the boom to limit the travel of the trolley.

F. Provide a locking device to prevent boom swivel when desired.

2.04 TROLLEY HOIST

A. Provide low headroom manual trolley hoist on the jib crane.

B. The trolley hoist shall be an integrally built-geared trolley and hoist combination capable of operating on the jib crane boom.

C. Provide sufficient chain to allow a lift of 22’-0” feet.

D. The hoist motor shall have 0.6 horsepower minimum.
   1. The hoist shall have a minimum speed of 8 ft/min.
   2. The motor electrical characteristics shall be 460 volts alternating current, 3 phase, and 60 hertz.
   3. Provide an overload warning device.

E. Manufacturers: One of the following or equal:
   1. GORBEL
   2. Columbus McKinnon.
   3. Yale and Towne, Division of Eaton, Inc.
   4. ACCO/Wright.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Adjust jib crane so that boom is level.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning, 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 1 day minimum.
      b. Functional Testing: 1 trips, 1 day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.

C. Functional testing:
   1. Jib crane system:
      a. Test witnessing: Non-witnessed.
      b. Conduct Level 2 General Equipment Performance Test.
   2. Electrical and Controls:
      a. Test witnessing: Non-witnessed.
      b. Conduct testing as specified in Section 17950 - Commissioning for Instrumentation and Controls.

END OF SECTION

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SECTION 15050

COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic design and performance requirements for building mechanical equipment and process mechanical equipment.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:
   1. 6001-E08 - Design and Selection of Components for Enclosed Gear Drives.

B. American Bearing Manufactures Association (ABMA) Standards:
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. American Petroleum Institute (API):
   1. 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A48 - Standard Specification for Gray Iron Castings.
   3. A125 - Standard Specification for Steel Springs, Helical, Heat-Treated.
   4. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   5. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   6. A320 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
   7. A536 - Standard Specification for Ductile Iron Castings.
   8. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   9. B61 - Standard Specification for Steam or Valve Bronze Castings.
   10. B62 - Standard specification for Composition Bronze or Ounce Metal Castings.
   11. B505 - Standard Specification for Copper Alloy Continuous Castings.
   12. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
   13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   14. F594 - Standard Specification for Stainless Steel Nuts.

E. Hydraulic Institute (HI).

F. Occupational Safety and Health Administration (OSHA).

G. Unified Numbering System (UNS).

1.03 DEFINITIONS

A. Resonant frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

B. Rotational frequency: The revolutions per unit of time usually expressed as revolutions per minute.

C. Critical frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

D. Peak vibration velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

E. Rotational speed: Same as rotational frequency.

F. Maximum excitation frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

G. Critical speed: Same as critical frequency.

H. Free field noise level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.

I. Operating weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 DESIGN REQUIREMENTS

A. General:
   1. Product requirements as specified in Section 01600 - Product Requirements.
   2. Project conditions as specified in Section 01610 - Project Design Criteria.
   3. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions specified in this Section.
   4. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
   5. Vibration considerations:
      a. Resonant frequency:
         1) For single-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
         2) For variable-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the range of operating frequencies.
      b. Design, balance, and align equipment to meet the vibration criteria specified in Section 15958 - Mechanical Equipment Testing.
   6. Equipment units weighing 50 pounds or more: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

B. Power transmission systems:
   1. V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a service factor of 1.5 or greater in accordance with manufacturer recommendations:
      a. Apply service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
      b. Apply service factors in accordance with AGMA 6001-E08, other applicable AGMA standards, or other applicable referenced standards.

C. Equipment mounting and anchoring:
   1. Mount equipment on cast-iron or welded-steel bases with structural steel support frames.
      a. Utilize continuous welds to seal seams and contact edges between steel members.
      b. Grind welds smooth.
   2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
   3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
   4. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load specified in Section 01612 - Seismic Design Criteria, and other loads as required for proper operation of equipment.
      a. For equipment with an operating weight of 400 pounds or greater and all equipment that is supported higher than 4 feet above the floor, provide calculations for:
         1) The operating weight and location of the centroid of mass for the equipment.
         2) Forces and overturning moments.
         3) Shear and tension forces in equipment anchorages, supports, and connections.
         4) The design of equipment anchorage, supports, and connections based on calculated shear and tension forces.
   5. Anchorage of equipment to concrete or masonry:
      a. Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
      b. Unless otherwise indicated on the Drawings, select and provide anchors from the types specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      c. Provide bolt sleeves around cast-in anchor bolts for 400 pounds or greater equipment.
         1) Adjust bolts to final location and secure the sleeve.
   6. Anchorage of equipment to metal supports:
      a. Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
   7. Unless otherwise indicated on the Drawings, install equipment supported on concrete over non-shrink grout pads as specified in this Section.

1.05 SUBMITTALS

A. As specified in Section 01600 - Product Requirements.

B. Product data:
   1. For each item of equipment:
      a. Design features.
      b. Load capacities.
      c. Efficiency ratings.
      d. Material designations by UNS alloy number or ASTM Specification and Grade.
      e. Data needed to verify compliance with the Specifications.
      f. Catalog data.
      g. Nameplate data.
      h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
   2. Gear reduction units:
      a. Engineering information in accordance with applicable AGMA standards.
      b. Gear mesh frequencies.

C. Shop drawings:
   1. Drawings for equipment:
      a. Drawings that include cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, base plate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial Installation Testing procedures.
   4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.
   5. Recommended or normal operating parameters such as temperatures and pressures.
   6. Alarm and shutdown setpoints for all controls furnished.

D. Calculations:
   1. Structural:
      a. Substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design requirements specified and seismic design criteria as specified in Section 01612 - Seismic Design Criteria.
   2. Mechanical:
      a. ABMA 9 or ABMA 11 L10 life for bearings calculation methods for drivers, pumps, gears, shafts, motors, and other driveline components with bearings.
      b. Substantiate that operating rotational frequencies meet the requirements of this Section.

c. Torsional analysis of power transmission systems: When torsional analysis specified in the equipment sections, provide:
   1) Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
   2) Results of analysis including first and second critical frequencies of system components and complete system.
d. Calculations shall be signed and stamped by a licensed engineer.

E. Operation and maintenance manuals:
1. As specified in Section 01730 - Operating and Maintenance Manuals.
2. Equipment with bearings:
   a. Include manufacturer and model number of every bearing.
   b. Include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.

F. Commissioning submittals: As specified in Section 01756 - Commissioning.

G. Project closeout documents: As specified in Section 01700 – Contract Closeout.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials as specified in Section 01600 - Product Requirements including special requirements for materials in contact with drinking water.

B. Ferrous materials:
1. Steel for members used in fabrication of assemblies: ASTM A36.
2. Iron castings: ASTM A48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
3. Ductile iron castings: ASTM A536, Grade 65-45-12, free from flaws and imperfections.
4. Galvanized steel sheet: ASTM A653, minimum 0.0635-inch (16-gauge).
5. Expanded metal: ASTM A36, 13-gauge, 1/2-inch flat pattern expanded metal.
6. Stainless steel:
   a. As specified in Section 721S Steel Structures and SP721S.
   b. In contact or within 36 inches of water, excluding air piping: Type 316 or 316L.
   c. Other locations: Type 304 or 304L.
   d. Source cleaning and passivation as specified in Section 721S Steel Structures and SP721S.

C. Non-ferrous materials:
1. Bronze in contact with wastewater: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C92200, or C93700 in accordance with ASTM B61, B62, B505, or B584, when not specified otherwise.
2. Aluminum: As specified in Section 05140 - Structural Aluminum.

D. Dielectric materials for separation of dissimilar metals:
1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials as specified.

E. Non-shrink grout and epoxy non-shrink grout: As specified in Section 03600 - Grouting.

2.02 ANCHORS AND FASTENERS

A. Mechanical anchoring to concrete and masonry:
   1. As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry:
      a. Type 316 stainless steel.
   2. Design as specified in Section 01612 - Seismic Design Criteria.

B. High-strength fasteners:
   1. As specified in Section 721S Steel Structures and SP721S.

C. Flange bolts:
   1. As specified in Section 15052 - Common Work Results for General Piping.

D. Mechanical assembly fasteners:
   1. Stainless steel:
      a. High-temperature service or high-pressure service:
         1) Bolts: ASTM A193, Grade B8 (Type 304) or Grade B8M (Type 316), Class 1, heavy hex.
         2) Nuts: ASTM A194, Grade 8, heavy hex.
         3) Washers: Alloy group matching bolts and nuts.
      b. Low-temperature service:
         1) Bolts: ASTM A320, Grade B8 (Type 304) or Grade B8M (Type 316), Class 1, heavy hex.
         2) Nuts: ASTM A194, Grade 8 (Type 304) or Grade B8M (Type 316), heavy hex.
         3) Washers: Alloy group matching bolts and nuts.
      c. General service:
         1) Bolts: ASTM F593, Alloy Group 1 (Type 304) or Alloy Group 2 (Type 316).
         2) Nuts: ASTM F594, Alloy Group 1 (Type 304) or Alloy Group 2 (Type 316).
         3) Washers: Alloy group matching bolts and nuts.

2.03 SHAFT COUPLINGS

A. General:
   1. Type and ratings: Provide non-lubricated type, designed for not less than 50,000 hours of operating life.
   2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.

B. Shaft couplings for close-coupled electric-motor-driven equipment:
   1. Use for:
      a. Equipment 1/2 horsepower or larger.
      b. Reversing equipment.
      c. Equipment subject to sudden torque reversals or shock loading:
      d. Examples:
         1) Reciprocating pumps, blowers, and compressors.
         2) Conveyor belts.

2. Manufacturers: One of the following or equal:
    a. Lovejoy.
    b. T.B. Woods.
3. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
4. Manufacture flexible component of coupling from synthetic rubber or urethane.
5. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
6. Do not allow metal-to-metal contact between driver and driven equipment.

C. Shaft couplings for direct-connected electric-motor-driven equipment:
1. Use for 1/2 horsepower or larger and subject to normal torque, non-reversing applications.
2. Manufacturers: One of the following or equal:
    a. Rexnord.
    b. T.B. Woods.
3. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
4. Provide flexible connecting element of rubber and reinforcement fibers.
5. Provide service factor of 2.0.
6. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer couplings: Where cartridge-type mechanical seals or non-split seals are specified, provide a spacer-type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer:
1. Includes any engine-driven equipment.

2.04 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
1. Unless otherwise noted in the equipment section, provide cartridge-type, double mechanical shaft seals for pumps.
2. Provide a stuffing box large enough for a double mechanical seal.
3. Provide seal flush connections, (3/4-inch size unless another size is indicated on the Drawings).
4. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
5. Seal flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
    a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
    b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
    c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
    d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water).
    e. Double seal applications: Plan 54 (External seal water).

B. Mechanical seals: Provide seal types specified in the equipment sections and as specified.
   1. Provide seal types meeting the following requirements:
      a. Balanced hydraulically.
      b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
      c. O-ring: Viton™ 747.
      d. Gland: Type 316L stainless steel.
      e. Set screws: Type 316L stainless steel.
      f. Faces: Reaction bonded, silicon carbide.
      g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.
   2. Cartridge-type single mechanical:
      a. Manufacturers: One of the following or equal:
         1) Chesterton, S10.
         2) John Crane, 5610 Series.
   3. Cartridge-type double mechanical: Manufacturers:
      a. One of the following or equal:
         1) Chesterton, S20.
         2) John Crane, 5620 Series.
   4. Split-face single mechanical: Manufacturers:
      a. One of the following or equal:
         1) Chesterton, 442.
         2) John Crane, 3740.
   5. Cartridge-type flushless mechanical:
      a. Manufacturers: One of the following or equal:
         1) Chesterton, 156.
         2) John Crane, 5870.

2.05 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
   1. Made of alloys treated for hardness and for severe service.
   2. AGMA Class II service:
      a. Use more severe service condition when such is recommended by unit's manufacturer.
   3. Cast-iron housing with gears running in oil.
   4. Anti-friction bearings.
   5. Thermal horsepower rating based on maximum horsepower rating of prime mover, not actual load.
   6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.06 BELT DRIVES

A. Sheaves:
   1. Separately mounted on bushings by means of at least 3 pull-up bolts or cap tightening screws.
   2. When 2 sheave sizes are specified, provide separate belts sized for each set of sheaves.
   3. Statically balanced for all; dynamically balanced for sheaves that operate at a peripheral speed of more than 5,500 feet per minute.
   4. Key bushings to drive shaft.

B. Belts: Anti-static type when explosion-proof equipment or environment is specified.
   1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit:
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

C. Manufacturers: One of the following or equal:
   1. Dodge, Dyna-V belts with matching Dyna-V sheaves and Taper-Lock bushings.
   2. T.B. Woods, Ultra-V belts with matching Sure-Grip sheaves and Sure-Grip bushings.

2.07 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil-lubricated bearings: Provide either pressure lubricating system or separate oil reservoir splash-type system:
   1. Size oil-lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the temperature 15 degrees Fahrenheit above the maximum design temperature as specified in Section 01610 - Project Design Criteria.
   2. Provide an external oil cooler when required to satisfy the specified operating conditions:
      a. Provide air-cooled system if a water-cooling source is not indicated on the Drawings.
      b. Equip oil cooler with a filler pipe and external level gauge.

C. Grease lubricated bearings, except those specified to be factory sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
   1. Lubrication lines and fittings:
      a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
      b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
      c. Use standard hydraulic-type grease supply fittings:
         1) Manufacturers: One of the following or equal:
            a) Alemite.
            b) Zerk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 L10 life for bearings rating life of not less than 50,000 hours.

2.08 MOTORS

A. As specified in Section 16222 - Electric Motors, Induction, 600 Volts and Below.

2.09 GEAR MOTORS

A. Motors as specified in Section 16222 - Electric Motors, Induction, 600 Volts and Below.

B. Helical gearing for parallel shaft drives and worm gearing for right-angle drives.

C. Manufactures: One of the following or equal:
   1. Baldor Electric Company.
   2. Bodine Electric Company.

2.10 VENDOR CONTROL PANELS

A. As specified in Section 13390 - Packaged Control Systems.

2.11 EQUIPMENT SUPPORT FRAMES

A. Bolt holes shall not exceed bolt diameter by more than 25 percent, up to a limiting maximum diameter oversize of 1/4-inch.

2.12 PIPING AND VALVES

A. Piping as specified in Section 15052 - Common Work Results for General Piping.

B. Valves as specified in Section 15110 - Common Work Results for Valves.

2.13 SAFETY EQUIPMENT

A. Safety guards:
   1. Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.
   2. Requirements:
      a. Allow visual inspection of moving parts without removal.
      b. Allow access to lubrication fittings.
      c. Prevent entrance of rain or dripping water for outdoor locations.
      d. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.
   3. Materials:
      a. Sheet metal: Carbon steel, 12-gauge minimum thickness, hot-dip galvanized after fabrication.
      b. Fasteners: Type 304 stainless steel.

B. Insulation:
   1. Insulate all surfaces with normal operating temperatures above 120 degrees Fahrenheit when surface is within 7.5 feet height from any operating floor or level.

2. Insulation thickness such that temperature is below 120 degrees Fahrenheit.
3. Insulation Type 3 and cover Type 5 as specified in Section 15082 - Piping Insulation.

C. Warning signs:
1. Provide warning signs in accordance with OSHA requirements for equipment that starts automatically or remotely.
2. Material, sign size, and text: As specified in Section 10400 - Signage.
3. Mount warning signs with stainless steel fasteners at equipment.

2.14 SPRING VIBRATION ISOLATORS

A. Design requirements:
1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
2. Use steel coil springs.
3. Design vibration isolators in accordance with seismic design criteria as specified in Section 01612 - Seismic Design Criteria.

B. Performance requirements: Minimum spring deflection of 1-inch under static load and capable of limiting transmissibility to 10 percent maximum at design operating load.

C. Manufacturers: One of the following or equal:
1. California Dynamics Corporation, Type RJSD.
2. Mason Industries, equivalent product.

D. Materials:
1. Fabricate isolators using welded-steel or shatterproof ductile iron in accordance with ASTM A536 Grade CS-45-12.
2. Spring steel: ASTM A125.

2.15 NAMEPLATES

A. Fastened to equipment at factory in an accessible and visible location.

B. Stainless steel sheet engraved or stamped with text, holes drilled or punched for fasteners.

C. Fasteners: Number 4 or larger oval head stainless steel screws or drive pins.

D. Text:
1. Manufacturer’s name, equipment model number and serial number, motor horsepower when appropriate, and identification tag number.
2. Indicate the following additional information as applicable:
   a. Maximum and normal rotating speed.
   b. Service class per applicable standards.
3. Include for pumps:
   a. Rated total dynamic head in feet of fluid.
   b. Rated flow in gallons per minute.
   c. Impeller, gear, screw, diaphragm, or piston size.

4. Include for gear reduction units:
    a. AGMA class of service.
    b. Service factor.
    c. Input and output speeds.

2.16 SHOP FINISHES

A. Provide appropriate factory coatings as specified in Section 09960 - High-Performance Coatings.
    1. Motors and gear reducers: Shop finish paint with manufacturer's standard coating, unless otherwise specified in the individual equipment specification.

2.17 SPECIAL TOOLS

A. Supply 1 set of special tools as specified in Section 01600 - Product Requirements.

2.18 SOURCE TESTING

A. Testing requirements unless specified otherwise in the individual equipment specifications:
    1. Mechanical equipment: Level 1 General Equipment Performance Test as specified in Section 15958 - Mechanical Equipment Testing.
    2. Motors: As specified in Section 16222 - Electric Motors, Induction, 600 Volts and Below.
    3. Vendor control panels: As specified in Section 17950 - Commissioning for Instrumentation and Controls.

2.19 SHIPPING

A. As specified in Section 01600 - Product Requirements.

B. Prior to shipment of equipment:
    1. Bearings (and similar items):
        a. Pack separately or provide other protection during transport.
        b. Greased and lubricated.
    2. Gear boxes:
        a. Oil filled or sprayed with rust preventive protective coating.
    3. Fasteners:
        a. Inspect for proper torques and tightness.

PART 3 EXECUTION

3.01 DELIVERY, HANDLING, STORAGE, AND PROTECTION

A. As specified in Section 01600 - Product Requirements.

B. Inspect fasteners for proper torques and tightness.

C. Storage:
    1. Bearings:
        a. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
    2. Gear boxes:
        a. Inspect to verify integrity of protection from rust.

D. Protection:
    1. Equipment Log shall include description of rotation performed as part of maintenance activities.

3.02 INSTALLATION

A. Field measurements:
    1. Prior to shop drawings preparation, take measurements and verify dimensions indicated on the Drawings.
    2. Ensure equipment and ancillary appurtenances fit within available space.

B. Sequencing and scheduling:
    1. Equipment anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place.
    2. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. Metal work embedded in concrete:
    1. Accurately place and hold in correct position while concrete is being placed.
    2. Clean surface of metal in contact with concrete immediately before concrete is placed.

D. Concrete surfaces designated to receive non-shrink grout:
    1. Heavy sandblast concrete surface in contact with non-shrink grout.
    2. Clean concrete surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bond to non-shrink grout.
    3. Saturate concrete with water. Concrete shall be saturated surface damp at time non-shrink grout is placed.

E. Install equipment in accordance with manufacturer's installation instructions and recommendations.

F. Lubrication lines and fittings:
    1. Support and protect lines from source to point of use.
    2. Fittings:
        a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
        b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
        c. Fittings for underwater bearings: Bring fittings above water surface and mount on edge of structure above.

G. Alignment of drivers and equipment:
   1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
   2. Comply with procedures of appropriate HI, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
      a. Maximum total coupling offset (not the per-plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).
      b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.
   3. Use reverse-indicator arrangement dial-type or laser-type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
   4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation, and axial spacing tolerances of the coupling.
   5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation.
      a. Allow minimum 48 hours for grout to harden.
      b. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment.
      c. Correct alignment as required.
   6. After functional testing is complete, dowel motor or drivers and driven equipment:
      a. Comply with manufacturer's instructions.

H. Grouting under equipment bases, baseplates, soleplates, and skids:
   1. Unless otherwise indicated on the Drawings, grout with non-shrink grout as specified in Section 03600 - Grouting.
      a. Non-shrink epoxy grout required only when indicated on the Drawings.
   2. Comply with equipment manufacturer's installation instructions for grouting spaces, and tolerances for level and vertical and horizontal alignment.
   3. Install grout only after:
      a. Equipment is leveled and in proper alignment.
      b. Piping connections are complete and in alignment with no strain transmitted to equipment.
   4. Do not use leveling nuts on equipment anchors for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting.
   5. Use jack screws for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting following the procedure defined below:
      a. Drill and tap equipment base plates, sole plates, and skids for jack screws.
      b. Use suitable number and size of jack screws.
      c. End of jack screws shall bear on circular steel plates epoxy bonded to equipment foundation.
      d. Jack screw threads that will be in contact with grout: Wrap with multiple layers of tape or other material, acceptable to Engineer, to prevent grout from bonding to threads.

e. Place and cure grout as specified in Section 03600 - Grouting.
f. After grout is cured, remove jack screws and material used to prevent bonding to grout.
    1) Provide jack screws to Owner for future use.
g. Tighten equipment anchors in accordance with equipment manufacturer requirements.
h. Fill holes where jack screws have been removed with grout.
i. Cure as specified in Section 03600 - Grouting.

6. For equipment bases, baseplates, soleplates, and skids where it is not practical to use jack screws, use steel wedges and shims.
    a. Wrap wedges and shims that contact grout with multiple layers of tape or other material, acceptable to Engineer, to prevent grout from bonding.
    b. Place and cure grout as specified in Section 03600 - Grouting.
    c. Remove wedges or shims.
    d. Tighten equipment anchors to in accordance with equipment manufacturer requirements.
    e. Fill voids where wedges and shims have been removed with grout.
    f. Cure as specified in Section 03600 - Grouting.
7. Preparation of equipment bases, baseplates, soleplates, and skids for grouting:
    g. Metal in contact with grout: Grit blast to white metal finish.
    h. Clean surfaces of equipment bases, baseplates, soleplates, and skids in contact with grout of dirt, dust, oil, grease, paint, and other material that will reduce bond.
7. Preparation of concrete equipment foundation for grouting:
    a. Rough concrete surfaces in contact with grout.
    b. Concrete contact surface shall be free of dirt, dust, laitance, particles, loose concrete, or other material or coatings that will reduce bond.
    c. Saturate concrete contact surface area with water for minimum of 24 hours prior to grouting.
    d. Remove standing water just prior to grout placement, using clean rags or oil-free compressed air.

8. Forms and header boxes:
    a. Build forms for grouting of material with adequate strength to withstand placement of grouts.
    b. Use forms that are rigid and liquid tight. Caulk cracks and joints with an elastomeric sealant.
    c. Line forms with polyethylene film for easy grout release. Forms carefully waxed with 2 coats of heavy-duty paste wax will also be acceptable.
9. Grout placement requirements:
    a. Minimum ambient and substrate temperature: 45 degrees Fahrenheit and rising:
        1) Conform to grout manufacturer’s temperature requirements.
    b. Pour grout using header box.
    c. Keep level of grout in header box above bottom of equipment bases, baseplates, soleplates, and skids at all times to prevent air entrapment.
    d. Grout shall flow continuously from header box to other side of forms without trapping air or forming voids.
    e. Vibrate, rod, or chain grout to facilitate grout flow, consolidate grout, and remove entrapped air.

f. After grout sets, remove forms and trim grout at 45-degree angle from bottom edge of equipment bases, baseplates, soleplates, and skids.
g. Cure as specified in Section 03600 - Grouting.

I. Field welding:
1. Use welding procedures, welders, and welding operators qualified and certified in accordance with AWS D1.1.
2. Shielded arc welding.

J. Field finishes:
1. Protect motors.
2. Clean equipment.
3. Apply primer and coating systems as specified in Section 09960 - High-Performance Coatings requirements.

K. Special techniques:
1. Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

L. Tolerances:
1. Completed equipment installations: Comply with requirements for intended use and specified vibration and noise tolerances.

M. Warning signs:
1. Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional testing requirements unless specified otherwise in the individual equipment specifications:
1. Mechanical equipment: Level 1 tests as specified in Section 15958 - Mechanical Equipment Testing.
2. Motors: As specified in Sections 16222 - Electric Motors, Induction, 600 Volts and Below and 16800 - Calibrations, Testing and Settings.
3. Vendor control panels: As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

END OF SECTION

SECTION 15052

COMMON WORK RESULTS FOR GENERAL PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic materials and methods for metallic and plastic piping systems.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24.
   2. B16.47 - Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard.

B. American Water Work Association (AWWA):
   1. C105 - Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
   2. C207 - Standard for Steel Pipe Flanges for Waterworks Services-Size 4 In. Through 144 In.

C. ASTM International (ASTM):
   1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   2. A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   3. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
   4. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   5. F37 - Standard Test Methods for Sealability of Gasket Materials.
   6. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements of Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

D. NSF International (NSF).

1.03 DEFINITIONS

A. Buried pipes: Pipes that are buried in the soil with or without a concrete pipe encasement.

B. Exposed pipe: Pipes that are located above ground, or located inside a structure, supported by a structure, or cast into a concrete structure.

C. Underground pipes: Buried pipes - see A. above.

D. Underwater pipes: Pipes below the top of walls in basins or tanks containing water.

E. Wet wall: A wall with water on at least 1 side.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials as specified in Section 01600 - Product Requirements including special requirements for materials in contact with drinking water.

2.02 ESCUTCHEONS

A. Material: Chrome-plated steel plate.

B. Manufacturers: One of the following or equal:
   1. Dearborn Brass Co., Model Number 5358.
   2. Keeney Manufacturing Co., Model Number 102 or Number 105.

2.03 LINK TYPE SEALS

A. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Links to form a continuous rubber belt around the pipe.
   3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.
   4. Hardware to be Type 316 stainless steel.
      a. Provide anti-galling lubricant for threads.

B. One of the following or equal:
   1. Link-Seal.
   2. Pipe Linx.

2.04 FLANGE BOLTS AND NUTS

A. General:
   1. Washer:
      a. Provide a washer for each nut.
      b. Washer shall be of the same material as the nut.
   2. Nuts: Heavy hex-head.
   3. Cut and finish flange bolts to project:
      a. A maximum of 1/4-inch beyond outside face of nut after assembly.
   4. Tap holes for cap screws or stud bolts when used.
   5. Lubricant for stainless steel bolts and nuts:
      a. Chloride-free.
      b. Manufacturers: One of the following or equal:
         1) Huskey FG-1800 Anti-Seize.
         2) Weicon Anti-Seize High-Tech.

B. For ductile iron pipe:
   1. On exposed pipes with pressures equal to or less than 150 pounds per square inch gauge (psig):
      a. Bolts: ASTM A307, Grade B.
      b. Nuts: ASTM A563, Grade A.
      c. Bolts and Nuts: Hot-dip galvanized in accordance with ASTM F2329.
   2. On exposed pipes with pressures greater than 150 psig:
      a. Bolts: ASTM A193, Grade B.
      b. Nuts: ASTM A194, Grade 2H.
      c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
   3. On underwater pipes and pipes adjacent to wet walls:
      a. Bolts: ASTM A193, Grade B8M.
      b. Nuts: ASTM A194, Grade 8M.
   4. On buried pipes:
      a. Bolts: ASTM A193, Grade B8M.
      b. Nuts: ASTM A194, Grade 8M for nuts.

C. Plastic pipe:
   1. On exposed pipes:
      a. Bolts: ASTM A307, Grade B.
      b. Nuts: ASTM A563, Grade A.
      c. Bolts and Nuts: Hot-dip galvanized in accordance with ASTM F2329.
   2. On underwater pipes and pipes adjacent to wet walls:
      a. Bolts: ASTM A193, Grade B8M.
      b. Nuts: ASTM A194, Grade 8M.

D. Steel pipe:
   1. On exposed pipes:
      a. For ASME B16.5 Class 150 flanges and AWWA C207 Class D flanges:
         1) Bolts: ASTM A307, Grade B.
         2) Nuts: ASTM A563, Grade A.
         3) Bolts and Nuts: Hot-dip galvanized in accordance with ASTM F2329.
      b. For ASME B16.5 and B16.47 Class 300 flanges and AWWA C207 Class E and F flanges:
         1) Bolts: ASTM A193, Grade B7.
         2) Nuts: ASTM A194, Grade 2H.
   2. On underwater pipes and pipes adjacent to wet walls:
      a. Bolts: ASTM A193, Grade B8M.
      b. Nuts: ASTM A194, Grade 8M.

2.05 GASKETS

A. General.
   1. Gaskets shall be suitable for the specific fluids, pressure, and temperature conditions.
   2. Capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure.

B. Gaskets for flanged joints in ductile iron and steel piping for sewage service:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 250 degrees Fahrenheit, and raw sewage service.

2. Gasket material:
    a. SBR or neoprene elastomer with minimum Shore A hardness value of 70.
    a. Reinforcement: Cloth or synthetic fiber.
    b. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8 inch thick for 10-inch and larger pipe.
3. Manufacturers: One of the following or equal:
    a. Pipe less than 48 inches in diameter:
        1) Garlock, Style 7797.
        2) John Crane, similar product.
    b. Pipe 48 inches in diameter and larger:
        1) Garlock, Style 3760.
        2) John Crane, similar product.

C. Gaskets for flanged joints in polyvinyl chloride and polyethylene piping:
1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, with low flange bolt loadings, temperatures equal to and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
2. Material:
    a. Chemical systems: 0.125-inch thick Viton™ rubber.
    b. Sewer and water: 0.125-inch thick SBR.
3. Manufacturers: One of the following or equal:
    a. Garlock.
    b. John Crane, similar product.

D. Gaskets for flanged joints in low pressure air piping:
1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 300 degrees Fahrenheit, and compressed air service.
2. Material: EPDM elastomer, 1/8-inch thick, 60 Shore hardness, smooth surface.
3. Manufacturers: One of the following or equal:
    a. Garlock, Style 8314.
    b. John Crane, similar product.

E. Gaskets for flanged joints in ductile iron or steel water piping:
1. Suitable for hot or cold water, pressures equal to and less than 150 pounds per square inch gauge, and temperatures equal to and less than 160 degrees Fahrenheit.
2. Material:
    a. SBR or neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
3. Manufacturers: One of the following or equal:
    a. Garlock, Bluegard 3300.
    b. John Crane, similar product.

F. Gaskets for flanged joints in ductile iron or steel drinking water piping meeting NSF requirements:
1. Suitable for hot or cold water, pressures equal to or less than 150 pounds per square inch gauge, and temperatures equal to or less than 160 degrees Fahrenheit.

2. Material:
    a. EPDM material with 80 Shore A durometer rating.
3. Manufacturers: One of the following or equal:
    a. Garlock, 98206.
    b. John Crane, similar product.

G. Gaskets for grooved joints in ductile iron:
1. Material to be used for following services unless otherwise specified:
    a. FlushSeal® type or equal
        1) For liquid service:
            a) Halogenated Butyl: Grade M; for temperatures to 200 degrees Fahrenheit.
            b) Nitrile: Grade S; for temperatures to 180 degrees Fahrenheit.
        2) For air service: Fluoroelastomer.

H. Gaskets for grooved joints in steel piping:
1. Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness.
    a. Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
    b. Gaskets for use with cement-mortar lined steel piping for temperatures less than 180 degrees Fahrenheit shall be captured between the ends of the pipe to protect exposed metal from corrosion, and shall be made of nitrile in accordance with ASTM D2000, Line Call Out 2CA615A25B24.

2.06 REPAIR BANDS

A. Design requirements:
1. In accordance with AWWA C230.

B. Materials:
1. Shells: Type 304 stainless steel.
2. Lugs: Removable epoxy coated ductile iron in accordance with ASTM A536.
3. Bolts and nuts: 304 Stainless Steel with fluorpolymer coated nuts.
4. Gaskets: Compounded for water and sewer service.

C. Manufacturers: One of the following or equal:
1. Romac Industries, Inc.
2. Smith-Blair Inc.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Piping drawings:
    a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.

b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
    1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.

2. Piping alternatives:
    a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
    b. Alternative pipe ratings:
        1) Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price.
        2) Piping of different material may not be substituted in lieu of specified piping.
    c. Valves in piping sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
    d. Grooved joints: Use couplings, flange adapters, and fittings of the same manufacturer.
        1) Manufacturer's factory trained representative:
            a) Provide on-site training for Contractor's field personnel.
            b) Periodically visit the jobsite to verify Contractor is following best recommended practices.
        2) Distributor's representative is not considered qualified to conduct the training or jobsite visits.
    e. Flanged joints: where 1 of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.
3. Unless otherwise indicated on the Drawings, piping at pipe joints, fittings, couplings, and equipment shall be installed without rotation, angular deflection, vertical offset, or horizontal offset.

B. Wall and slab penetrations:
1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
    a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
    b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
    c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
    d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.
3. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.
4. Core drilled openings:
    a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Engineer.

b. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device.
c. Remove dust and debris from hole using compressed air.

C. Exposed piping:
1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings:
a. Install piping runs plumb and level, unless otherwise indicated on the Drawings.
1) Slope plumbing drain piping with a minimum of 1/4-inch per foot downward in the direction of flow.
2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
3. Support piping: As specified in Sections 15061 - Pipe Supports, 15062 - Preformed Channel Pipe Support System, and 15063 - Non-Metallic Pipe Support System:
a. Do not transfer pipe loads and strain to equipment.
4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
5. Assemble piping without distortion or stresses caused by misalignment:
a. Match and properly orient flanges, unions, flexible couplings, and other connections.
b. Do not subject piping to bending or other undue stresses when fitting piping.
c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
e. Alter piping assembly to fit, when proper fit is not obtained.
f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Buried piping:
1. Bury piping with minimum 3-foot cover without air traps, unless otherwise indicated on the Drawings.
2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench.
a. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
3. Laying piping:
a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
b. Place piping with top or bottom markings with markings in proper position.
c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.

e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

4. Concrete encase buried pipe installed under concrete slabs or structures.

E. Venting piping under pressure:
1. Lay piping under pressure flat or at a continuous slope without air traps, unless otherwise indicated on the Drawings.
2. Install plug valves as air bleeder cocks at high points in piping.
a. Provide 1-inch plug valves for water lines, and 2-inch plug valves for sewage and sludge lines, unless otherwise indicated on the Drawings.
3. Provide additional pipe taps with plug cocks and riser pipes along piping as required for venting during initial filling, disinfecting, and sampling.
4. Before piping is placed into service, close plug valves and install plugs. Protect plugs and plug valves from corrosion in as specified in Section 09960 - High-Performance Coatings.

F. Condensate in digester gas piping:
1. Slope digester gas piping to drip traps or low-point drains at minimum 1/2-inch per foot where condensate flows against the gas or 1/4-inch per foot where condensate flows with gas.
2. Install tapered filler pieces between flanges at high points of straight runs to provide for slope reversals.
a. Do not subject piping to high stresses in order to change direction.
3. Provide pipe taps, threaded nipples, and 1-inch plug valves at low points in concrete utility boxes with lids.

A. Restraining buried piping:
1. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
a. When piping is underground, use concrete thrust blocks, mechanical restraints, or push-on restraints.
b. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping.
2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
a. During testing, provide suitable temporary restraints where piping does not require permanent restraints.
3. Place concrete thrust blocks against undisturbed soil.
4. Place concrete so piping joints, fittings, and other appurtenances are accessible for assembly and disassembly.
5. Provide underground mechanical restraints where specified in the Piping Schedule.

B. Restraining above ground piping:
1. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
a. When piping is aboveground or underwater, use mechanical or structural restraints.
b. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping.

2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
    a. During testing, provide suitable temporary restraints where piping does not require permanent restraints.

G. Connections to existing piping:
1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
    a. Protect domestic water/potable water supplies from contamination:
        1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
        2) Provide devices approved by Owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

H. Connections to in-service piping:
1. As specified in Section 01140 - Work Restrictions.

I. Connections between ferrous and nonferrous metals:
1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
2. Nonferrous metals include aluminum, copper, and copper alloys.

J. Flanged connections between dissimilar metals such as ductile iron pipe and steel pipe:
1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.02 CLEANING

A. Piping cleaning:
1. Upon completion of installation, clean piping interior of foreign matter and debris.
2. Perform special cleaning when required by the Contract Documents.

B. Cleaning potable water piping:
1. Flush and disinfect potable water piping as specified in Section 01757 - Disinfection.

C. Cleaning and drying of dry chlorine gas or liquid chlorine piping:
1. Coordinate with Owner and attend a pre-cleaning meeting with Owner before cleaning chlorine piping.
2. Work with Owner during cleaning and conform to plant operational and shut down constraints.

3. Clean chlorine pressure piping in accordance with the requirements of the Chlorine Institute-Pamphlet 6 and meet the following requirements.
4. Do not put water into any of the chlorine gas or liquid piping.
5. Blow chlorine piping clean of loose debris with compressed air at 4,000 fpm.
6. Clean chlorine piping by pulling clean cloths saturated with an approved solvent through piping:
    a. Do not use hydrocarbons or alcohols that may react with chlorine.
    b. Use solvents in accordance with manufacturer's safety recommendations to avoid serious physiological effects.
    c. Remove all dirt and debris of any nature from the chlorine lines.
7. Disassemble and clean valves and equipment that have oil residues before installation.
8. Dry piping immediately before effecting final connections for service.
    a. Keep piping sealed to prevent moisture from entering chlorine piping.
    b. Supply compressors, air dryers, and dew point testing equipment necessary to dry and test for dryness the new chlorination system piping.
    c. Drying procedure:
        1) Pass dry commercial grade nitrogen gas that has a dew point of minus 40 degrees Fahrenheit or less through the piping until exhausted air at three Engineer-approved locations has a dew point of minus 40 degrees Fahrenheit.
        2) Confirm dew point with a hygrometer.
        3) Allow several hours for drying piping.
        4) Re-dry the chlorine piping system in the event subsequent work opens any part of the system to the atmosphere.

D. Cleaning and drying chlorine gas vacuum piping:
1. Blow pipe clean of loose debris with instrument-grade clean and dry compressed air.
2. Ensure that pipe is open and not valved off at the end of the section to be cleaned so that pipe does not become pressurized. DO NOT PRESSURIZE PVC WITH COMPRESSED AIR.
3. Do not flush chlorine gas vacuum piping with water.
4. After cleaning, purge air out with commercial grade dry nitrogen that has a dew point of minus 40 degrees Fahrenheit or less.

E. Cleaning chlorine piping:
1. Clean chlorine piping by pulling clean cloths saturated an approved solvent through piping:
    a. Do not use hydrocarbons or alcohols that may react with chlorine.
    b. Use solvents in accordance with manufacturer's safety recommendations to avoid serious physiological effects.
2. Disassemble and clean valves and equipment that have oil residues before installation.
3. Dry piping immediately before effecting final connections for service.
    a. Keep piping kept sealed to prevent moisture from entering chlorine piping.
    b. Drying procedure shall be as follows:
        1) Pass steam through piping from the high end until piping is thoroughly heated. While steaming, allow condensate and foreign matter to drain out.
        2) Stop steaming and drain pockets and low points.

3) While piping is hot, blow dry air through piping until piping is dry.
   a) Use dry air with a dew point of minus 40 degrees Fahrenheit or below.
4) Continue blowing dry air through piping until exhausted air has a dew point of minus 30 degrees Fahrenheit or below.
5) Allow several hours for drying piping.

F. Cleaning air piping:
1. Perform special cleaning of filtered air piping from the intake clean air plenums to the discharge points and high-pressure air piping.
   a. Protect surfaces from contamination.
2. Special cleaning shall include wire brushing, power tool cleaning, wiping down with lint-free cloths, brooming, and vacuuming to remove rust, scale, weld spatter, dust, dirt, oil, and other matter deleterious to operation of the air system:
   a. Do not sandblast installed piping.
3. To the greatest extent possible, clean piping immediately prior to final closure of piping systems:
   a. Enter piping, clean and wipe down surfaces, and vacuum out residue.
   b. Clean surfaces not accessible to this cleaning operation after installation within 6 hours preceding installation.
4. Subsequent to cleaning, protect surfaces from contamination by dust, dirt, construction debris, and moisture, including atmospheric moisture:
   a. Whether or not pipe upstream has been cleaned, temporarily seal openings in partially completed work except when installation is actively in progress.
   b. When installation is actively in progress, seal openings at the end of each day's construction or when construction is temporarily stopped.
5. Suspend cleaning and seal openings when inclement weather, including dust storms, is imminent.
6. Use clean, dry air for testing the piping and other elements of the system.
7. Prior to introduction of air to the system, blow piping clean.
   a. Blow with maximum discharge rate possible for minimum 4 hours, using new blowers or compressors and filters.
8. Clean surfaces that become contaminated prior to acceptance.

G. Cleaning steam piping:
1. Thoroughly clean steam piping, boiler feed water piping, and condensate return piping by flushing with water.
   a. Conduct cleaning operation after piping connections are completed and after piping has successfully passed pressure test.
2. Utilize potable quality water, softened to remove hardness, for flushing water.
   a. Provide temporary facilities and chemicals to add corrosion control additives to flushing water.
   b. Utilize recommendations of boiler manufacturer for type and quantity of corrosion control additives.
   c. When corrosion control additives are to be disposed of within treatment plant, use additives that are non-toxic to the treatment process.
3. When the boiler system includes a feed water softening system, this system may be utilized as source of flushing water.
   a. Provide adequately sized temporary storage tank when capacity of feed water softening system is less than required flow rate for flushing.

4. Flush piping with water in sufficient quantities to produce a flow velocity of 6 feet per second in the main pipe and branch lines.
5. Continue flushing until at least twice the volume of pipe has been flushed.
6. Disconnect steam traps and piping less than 1/2-inch in nominal diameter prior to flushing operation.
    a. After flushing operation is completed, drain entire system, and reconnect piping and steam traps.
7. When cleaning operation is complete, remove temporary piping, pumps, tanks, and chemicals used to accomplish pipe cleaning.
8. Prior to beginning cleaning operation, submit plan for the cleaning operation. Include details of equipment, procedures, and MSDS sheets for chemicals to be utilized.

H. Conduct pressure and leak test, as specified.

3.03 PIPING SCHEDULE

A. Refer to Drawings for piping schedule.

END OF SECTION

SECTION 15061

PIPE SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Supports for pipe, fittings, valves, and appurtenances.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   3. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

B. Manufacturer's Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals

B. Product data.
   1. Design features.
   2. Load capacities.
   3. Material designations by UNS alloy number or ASTM Specification and Grade.
   4. Data needed to verify compliance with the Specifications.
   5. Catalog data.
   6. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

2.02 MATERIALS

A. General:
   1. Hot dip galvanized:
      a. Fabricate as specified in Section 721S - Steel Structures and SP721S.
      b. Hot dip after fabrication of support in accordance with ASTM A123.
      c. Repair galvanized surface as specified in Section 721S - Steel Structures and SP721S.
   2. Stainless steel.
      a. Fabricate as specified in Section 721S - Steel Structures and SP721S.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.
      c. At the shop, perform pickling and passivation on all surfaces inside and out in accordance with ASTM A380 or A967.
         1) Passivation treatments using citric acid are not allowed.
      d. Field welding is prohibited unless specifically allowed by the Owner. All field welds shall be passivated.

B. Outdoor areas: Areas exposed to the natural outdoor environment:
   1. Hot Dip Galvanized, or as indicated on the Drawings.

C. Indoor areas: Areas exposed to an indoor environment including galleries and tunnels:
   1. Hot Dip Galvanized, or as indicated on the Drawings.

D. Submerged, 3 feet or less above water level in a structure, or inside a water bearing structure:
   1. Type 316L Stainless Steel, or as indicated on the Drawings.

E. Stainless steel piping system:
   1. Type 304L Stainless Steel, or as indicated on the Drawings.

F. Chemical containment areas and chemical piping:
   1. Type 316L Stainless Steel, or as indicated on the Drawings.

G. Fasteners:
   1. As specified in Section 721S - Steel Structures and SP721S.

2.03 PIPE SUPPORTS

A. Hanger rods: Sized to match suspended pipe hanger, or as indicated on the Drawings:
   1. Manufacturers: One of following or equal:
      a. For stainless steel piping:
         1) Bergen-Power, Figure 133.
         2) Nibco-Tolco, Figure 103.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 140.
         2) Bergen-Power, Figure 133.
         3) Cooper B-Line Systems, Inc., Figure B3205.

B. Hanger rods, continuously threaded: Sized to match suspended pipe hanger, or as indicated on the Drawings:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Bergen-Power, Figure 94.
         2) FM Stainless Fasteners.
      b. For steel and ductile iron piping:
         1) Anvil International, Figure 146.
         2) Bergen-Power, Figure 94.

C. Eye bolts:
   1. For stainless steel piping:
      a. Type 316 stainless steel, welded and rated equal to full load capacity of rod.
   2. For all other piping, unless indicated on the Drawings:
      a. Welded and rated equal to full load capacity of rod.

D. Welded eyebolt rod:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 101.
         2) FM Stainless Fasteners.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 278.
         2) Bergen-Power, Figure 93.
         3) Cooper B-Line Systems, Inc., Figure B3210.

E. Adjustable ring hangers: MSS SP-58, Type 7 or Type 9 (system dependent):
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 1C.I.
         2) Bergen-Power, Figure 100SS.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 97.
         2) Cooper B-Line Systems, Inc., Figure B3172.

F. Adjustable clevis hangers: MSS SP-58, Type 1:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Cooper B-Line Systems, Inc., Figure B3100 or B3102.
         2) FM Stainless Fasteners, Figure 60.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 260 or Figure 590.
         2) Bergen-Power, Figure 100.
         3) Cooper B-Line Systems, Inc., Figure B3100 or B3102.

G. Adjustable clevis hangers for insulated pipe: Oversize:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 1A.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 300.

2) Bergen-Power, Figure 100EL.
3) Cooper B-Line Systems, Inc. Figure B3108.

H. Single rod hangers for steam pipe: MSS SP-58, Type 43; malleable iron or steel yoke and roller hangers; swivel to allow rotation of yoke on rod:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 324.
2) Cooper B-Line Systems, Inc., Figure B3110.
3) FM Fasteners, Figure 81.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 181.
2) Cooper B-Line Systems, Inc., Figure B3110.

I. Double rod hangers for steam pipe: MSS SP-58, Type 41:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) FM Stainless Fasteners, Figure 71.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 171.
2) Cooper B-Line Systems, Inc., Figure B3114.

J. Brackets: MSS SP-58, Type 32 with back plate; rated for 1,500 pounds:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 30M.
2) Cooper B-Line Systems, Inc., Figure B3066.
3) FM Stainless Fasteners, Figure 98.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 195.
2) Cooper B-Line Systems, Inc., Figure B3066.

K. Standard U-bolt: MSS SP-58, Type 24:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 110.
2) Cooper B-Line Systems, Inc., Figure B3188.
3) FM Stainless Fasteners, Figure 37.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 137.
2) Bergen-Power, Figure 283.
3) Cooper B-Line Systems, Inc., Figure B3188.

L. Riser clamps: MSS SP-58, Type 8:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3373.
2) FM Stainless Fasteners, Figure 61.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 261.
2) Bergen-Power, Figure 126.
3) Cooper B-Line Systems, Inc., Figure B3373.

M. Pipe clamps: MSS SP-58, Type 4:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 4.
            2) Cooper B-Line Systems, Inc., Figure 3140.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 212.
            2) Bergen-Power, Figure 175.
            3) Cooper B-Line Systems, Inc., Figure B3140.

N. Adjustable offset pipe clamp:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 4.
            2) Cooper B-Line Systems, Inc., Figure B3149.
            3) FM Stainless Fasteners, Figure 63.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 100.
            2) Cooper B-Line Systems, Inc., Figure B3149.

O. Offset pipe clamp:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 8.
            2) Cooper B-Line Systems, Inc., Figure 3148.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 103.
            2) Cooper B-Line Systems, Inc., Figure B3148.

P. Floor stand or stanchion saddles: MSS SP-58, Type 37. Provided with U-bolt hold down yokes:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 318.
            2) FM Stainless Fasteners, Figure 59.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 259.
            2) Bergen-Power, Figure 125.
            3) Cooper B-Line Systems, Inc., Figure B3090.
        c. Threaded pipe stand support stanchion. Match pipe support material.
            1) Anvil International, Figure 63T.
            2) Bergen-Power, Figure 138.
            3) Cooper B-Line Systems Inc., Figure B3088ST.

Q. Spring hangers:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Bergen-Power, Figure 920.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure B-268, Type G.
            2) Bergen-Power, Figure 920.

R. Welded beam attachment: MSS SP-58, Type 22:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 304.
         2) Cooper B-Line Systems, Inc., Figure 3083.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 66.
         2) Bergen-Power, Figure 113A or 113B.
         3) Cooper B-Line Systems, Inc., Figure B3083.

S. Heavy pipe clamp: MSS SP-58, Type 4:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 4H.
      b. For all other piping, unless called out otherwise on the drawings:
         1) Anvil International, Figure 216.
         2) Bergen-Power, Figure 298.

T. PTFE pipe slide assembly: MSS SP-58, Type 35 with lateral and vertical restraint:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 426.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 257, Type 3.
         2) Cooper B-Line Systems, Inc., Figure B3893.

U. Anchor bolts, concrete anchors, concrete inserts, powder-actuated fasteners, and sleeve anchors:
   1. Refer to Section 05190 – Mechanical Anchoring and Fastening to Concrete on Masonry.
   2. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
   3. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
   4. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
   5. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.
   6. Research Council on Structural Connections (RCSC):
      a. Specification for Structural Joints Using High-Strength Bolts (RCSC Specification).
   7. Fasteners: General:
      a. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
      b. Anchor bolts and anchor rods: Install as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      c. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry to the "snug-tight" condition.

d. Fasteners: High-strength carbon steel bolts:
   1) Connections with high-strength bolts shall in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.

PART 3 EXECUTION

3.01 INSTALLATION

A. Support, suspend, or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, overstressing, or movement of piping; and to prevent thrusts or loads on or against connected pumps, blowers, and other equipment.

B. Field verify support location, orientation, and configuration to eliminate interferences prior to fabrication of supports.

C. Carefully determine locations of inserts. Anchor to formwork prior to placing concrete.

D. Use flush shells only where indicated on the Drawings.

E. Do not use anchors relying on deformation of lead alloy.

F. Do not use powder-actuated fasteners for securing metallic conduit or steel pipe larger than 1-inch to concrete, masonry, or wood.

G. Suspend pipe hangers from hanger rods and secure with double nuts.

H. Install continuously threaded hanger rods only where indicated on the Drawings.

I. Use adjustable ring hangers or adjustable clevis hangers for 4-inch and smaller diameter pipe.

J. Use adjustable clevis hangers for pipe larger than 4 inches in diameter.

K. Secure pipes with double nutted U-bolts or suspend pipes from hanger rods and hangers.
   1. For stainless steel piping, use stainless steel U-bolts.
   2. For all other piping, use galvanized U-bolts.

L. Support spacing:
   1. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
   2. Support larger than 2-inch piping on horizontal and vertical runs at maximum 10 feet on center, unless otherwise specified.
   3. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.
   4. Support tubing, PVC pipe 1-inch and smaller, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing at intervals close enough to prevent sagging greater than 1/4-inch between supports.
   5. Do not suspend or support valves, pipe and fittings from another pipe or conduit.

M. Install supports at:
   1. Any change in direction.
   2. Both sides of flexible pipe connections.
   3. Base of risers.
   4. Floor penetrations.
   5. Connections to pumps, blowers, and other equipment.
   6. Valves and appurtenances.

N. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

O. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

P. Provide elbows or tees supported from floors with base fittings where indicated on the Drawings.

Q. Support base fittings with metal supports or when indicated on the Drawings support on concrete piers.

R. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

S. Support plumbing drainage and vents in accordance with plumbing code as specified in Section 01410 - Regulatory Requirements.

T. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plated, copper throughout, or isolated with neoprene or polyvinyl chloride tape.

U. Where pipe is insulated, install over-sized supports and hangers.

V. Install insulation shield in accordance with MSS SP-58, Type 40. Shield shall be galvanized steel unless otherwise specified or indicated on the Drawings.

W. Install riser clamps at floor penetrations and where indicated on the Drawings.

X. Coat support system components as specified in Section 09960 - High-Performance Coatings.

END OF SECTION

SECTION 15075

EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Equipment nameplates.
   2. Special items.

1.02 SUBMITTAL

A. Submit as specified in Section 01300 - Submittals.

B. Shop drawings:
   1. Product data.
   2. Installation instructions.

C. Samples.

1.03 QUALITY ASSURANCE

A. Regulatory requirements: Comply with Texas Commission on Environmental Quality (TCEQ):
   1. Chapter 217 – Design Criteria for Domestic Wastewater Systems.

PART 2 PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Material and fabrication:
   1. Stainless steel sheet engraved or stamped with text, holes drilled, or punch for fasteners.

B. Fasteners:
   1. Number 4 or larger oval head stainless steel screws or drive pins.

C. Text:
   1. Manufacturer’s name, equipment model number and serial number, identification tag number; and when appropriate, drive speed, motor horsepower with rated capacity, pump rated total dynamic head, and impeller size.

2.02 VALVE AND EQUIPMENT IDENTIFICATION

A. The Contractor shall furnish and install tags for all valves and equipment required for the Work. Identification tags are required for all tagged items shown on the P&IDs and the valve and equipment schedules on the Drawings.
   1. Tags shall be 1-inch by 3-inch rectangular, stainless steel tags with rounded corners and 3/16-inch hole.

2. Tags shall be furnished with a stainless steel braided wire with crimp combination suitable for attaching the tag to the operator base.
3. Tags shall be stamped in 1/2-inch high letter, or sized to fit within tag boundary if 1/2-inch high lettering cannot be used.
    a. Tags shall not be attached in such a way as to inhibit the operation of the valve or gate.
4. Buried valve tags shall be secured to concrete collar or stem with the specified valve or gate number.
5. Submit two (2) samples of the type of tag proposed and the manufacturer's standard letter styles to the Engineer for review.
6. Manufacturer: The following or equal:
    a. Marking Services Incorporated.

2.03 SPECIAL ITEMS

A. In addition, special coating of following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes
Steel guard posts	In accordance with standard details
Rotating equipment guards	Yellow

B. Paint minimum 2 inches high numbers on or adjacent to accessible valves, pumps, flowmeters, and other items of equipment which are indicated on the Drawings or in Specifications by number.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600 - Product Requirements.

3.02 PREPARATION

A. Prepare and coat surfaces of special items as specified in Section 09960 - High-Performance Coatings.

B. Prepare surface in accordance with product manufacturer's instructions.

END OF SECTION

SECTION 15076

PIPE IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pipe identification including the following:
   1. Pipe identification by color and legend.
   2. Underground warning tape.
   3. Tracer wire.
   4. Witness markers.
   5. Valve identification.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Submit following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following as specified in Section 01700 – Contract Closeout:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 ABOVE GROUND AND IN-CHASE PIPE IDENTIFICATION

A. Manufacturers:
   1. One of the following or equal:
      a. Seton, Opti Code Pipe Markers.
      b. Lab Safety Supply.
      c. Marking Services, Inc.

B. Materials:
   1. Pipe markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5 inches	1/2-inch
1.5 inches to 2 inches	3/4-inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

b. Marker colors:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontoxic solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

2. Coating: As specified in Section 09960 - High-Performance Coatings.
3. Pipe identification tags: Aluminum or stainless steel with stamped-in 1/4-inch high identifying lettering.
4. Pipe identification tag chains: Aluminum or stainless steel.
5. Snap-on markers: Markers with 3/4-inch high letters for 3/4 to 4-inch pipe or covering, or 5-inch high letters for 5-inch or larger pipe or cover:
    a. Manufacturers: One of following or equal:
        1) Brady BradySnap-On B-915.
        2) Seton Setmark.

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground warning tape:
    1. Manufacturer: One of the following or equal:
        a. Seton Name Plate Co.
        b. T. Christy Enterprises, Inc.
    2. Material:
        a. Polyethylene tape for prolonged underground use.
        b. Minimum tape thickness: 4 mils.
        c. Overall tape width: 6 inches.
        d. Message: “CAUTION” with the name of the service followed by “LINE BURIED BELOW.” in black lettering on colored background in accordance with approved APWA colors.
            1) Water: Blue.
            2) Sewer: Green.
            3) Telephone: Orange.
            4) Gas and other services: Yellow.
        e. Aluminum backing or solid aluminum core.

B. Tracer wire:
   1. Manufacturers: One of the following or equal:
      a. Kris-Tech Wire.
      b. Corrpro.
   2. Materials: One of the following or equal:
      a. Solid copper conductor
      b. Thickness minimum: 10 gauge.
      c. Insulation:
         1) Match insulation color to the color of the pipe being installed.
         2) UF type, direct bury.
         3) 30 mil HMWPE.
   3. Splicing Kit:
      a. Manufacturers: One of the following or equal:
         1) Ryall Electric Co., 3M Kit#82-A1.
   4. Station Box:
      a. Lid and collar materials: Cast iron.
      b. Able to withstand heavy traffic loading.
      c. Manufacturers: One of the following or equal:
         1) Farwest Corrosion Control Co, Glenn 4 Test Station.

C. Witness markers:
   1. Manufacturers: One of the following or equal:
      a. Carsonite Composites, Utility Marker.
      b. Hampton Technical Associates, Inc.
   2. Materials:
      a. Glass fiber and resin reinforced thermosetting composite material.
      b. UV resistant.
   3. Constructed as a single piece.
   4. Pointed at the bottom end.
   5. Information to be included on the marker:
      a. “Caution” (type of service) “Pipeline”.
      b. Phone number for Underground Service Alert.
      c. Phone number for Owner in case of emergency.
      d. Station number.
      e. Offset:
         1) Only provide offset if marker is not directly over the pipe.
      f. Name of appurtenance or fitting (e.g. 45, BO, ARV, etc.).

2.03 VALVE AND GATE IDENTIFICATION

A. Provide valve and gate schedule for each valve and gate in the Work with the following information:
   1. Identification number.
   2. Location.
   3. Type.
   4. Function.
   5. Normal operating position.

B. Identification tag requirements.
   1. Diameter: 2-inches.
   2. Material:
      a. Buried applications: Stainless steel or PVC.

b. Buried applications with concrete marker: Brass.
c. Above ground and in-chase applications: 19 gauge aluminum or PVC.

3. Stamp tags in 1/4-inch high letter:
4. Provide non-corrosive metal wire suitable for attaching the tag to the operator base.
5. Secure tags to valve or gate:
   a. Attach tags in such a way as to allow free and full operation of the valve or gate.
6. Buried applications with concrete marker: Secure tags to concrete marker.

C. Submittal requirements:
1. Submit 2 samples of the type of tag proposed and the manufacturer's standard color chart and letter styles to the Engineer for review.

D. Manufacturer: The following or equal:
1. Seton Name Plate Co.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600 - Product Requirements.

3.02 PREPARATION

A. Prepare and coat surfaces as specified in Section 09960 - High-Performance Coatings.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 ABOVE GROUND AND IN-CHASE PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Color code:
1. Paint piping with colors as scheduled in Piping Color Code and Marker Schedule.

C. Lettering and flow direction arrows:
1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4-inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.

D. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.

E. Label chemical tank fill pipelines at locations which are visible from chemical fill stations.

F. Metal tags:
   1. Where outside diameter of pipe or pipe covering is 5/8-inch or smaller, provide metal pipe identification tags instead of lettering.
   2. Fasten pipe identification tags to pipe with chain.
   3. Where tags are used, color code pipe as scheduled.

3.04 BURIED PIPING IDENTIFICATION

A. Underground warning tape:
   1. Place continuous run of warning tape in pipe trench, 12 inches above the pipe.

B. Tracer wire:
   1. Install on all non-metallic pipe.
   2. Install an electrically continuous run of tracer wire along the entire length of the pipe with wire terminations in valve boxes, vaults, or structures.
   3. Install tracer wire on top of the pipe and secure to pipe with tape a minimum of every 10 feet.
   4. Where approved by the Engineer, splice sections of wire together using approved direct bury wire nuts.
      a. Twisting the wires together is not acceptable.

C. Witness markers:
   1. Install over pipe in unpaved open-space areas at intervals not greater than 200 feet.
   2. Place markers at appurtenances located in unpaved areas.
   3. Embed markers at least 18 inches into the soil.

3.05 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self-adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers, and number markers where piping passes through walls or floors, at piping intersections and at maximum 15-foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

3.06 PIPING COLOR CODE AND MARKER SCHEDULE

Letters	Color of Pipe	Color of Bands	Color of Letters
Finished or Potable (cold)	Light blue	None	Black
Potable (hot)	Light blue	Red	Black
Non-potable or Raw	Light blue	Dark Gray	Black
Reclaimed or NPW Water	Purple	None	Black
Service Water (lines downstream from backflow prevention unit	Dark Blue	White	Red
Sample	Dark Blue	Black	White
Fire Protection	Red	None	Black
Hydrants	Aluminum	None	Black
Filter-to-Waste	Light Brown	None	Black
Wash Water Drain	Light Gray	None	Black
Sewage	Light Gray	None	Black
Solids	Dark Brown	None	White
Scum	Dark Brown	None	White
Drain	Dark Gray	None	White
Sump Pump Pipe Line	Dark Gray	Red	White
Alum	Yellow	Orange	Black
Polymer	White	Green	Black
Stainless Steel Pipe	White	Red	White

END OF SECTION

SECTION 15082

PIPING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Insulation for piping and related systems that are not plumbing systems.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
   2. C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   3. C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   4. C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
   5. C547 - Standard Specification for Mineral Fiber Pipe Insulation.
   6. C552 - Standard Specification for Cellular Glass Thermal Insulation.
   7. C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
   8. C929 - Standard Practice for Handling, Transporting, Shipping, Storage, Receiving, and Application of Thermal Insulation Materials for Use in Contact with Austenitic Stainless Steel.
   9. C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   10. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   11. D2310 - Standard Classification of Machine-Made "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe.
   12. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   13. E96 - Standard Test Methods for Water Vapor Transmission of Materials.

1.03 DEFINITIONS

A. Buried: Piping that is installed below buildings, foundations, or finish grade, either in soil or encased in concrete in soil.

B. Concealed: Piping above suspended ceilings and within walls, partitions, shafts, or service spaces and spaces not normally exposed to view but not buried.

C. Exterior: Piping that is installed outside a building or within a pipe trench or tunnel.

D. Flame spread and smoke density: Burning characteristics determined in accordance with ASTM E84.

E. Interior: Piping that is installed inside a building.

F. K factor: Thermal conductivity determined in accordance with ASTM C177 or C518.

G. Mineral fiber: Fibers manufactured of glass, rock, or slag processed from a molten state, with or without a binder.

H. Water vapor permeance: Water vapor transmission determined in accordance with ASTM E96 and expressed in units of perm-inch.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.
   1. Insulation properties: Include K factor, thickness, density, operating temperature limits, tensile strength, compressive strength, moisture absorption, flame spread, and smoke developed in accordance with ASTM E84 and corrosivity to stainless steel piping in accordance with ASTM C795.
   2. Jacket properties: Include covering material, cover thickness, tensile strength, tear strength, permeability in accordance with ASTM E96, flame spread, and smoke developed in accordance with ASTM E84, closure type or devices, and accessories.
   3. Insulating blankets: Include materials, performance characteristics, method of attaching to equipment, listing of locations where insulating blankets will be installed.
   4. Manufacturer's application instructions: Include assembly and application drawings and detailed instructions.
   5. Laboratory report: Provide certified laboratory report stating that insulation is not manufactured using chlorinated polymers and does not contain chlorides, bromides, sulfates, or fire-rated materials.

C. Provide warranty as specified in Section 01783 - Warranties and Bonds.

1.05 REGULATORY REQUIREMENTS

PART 2 PRODUCTS

2.01 PIPE INSULATION, GENERAL REQUIREMENTS

A. As specified in Section 01600 - Product Requirements.

B. Insulation thicknesses: Provide insulation thickness in inches in accordance with the following table. Insulation thickness shown is nominal. Manufacturing tolerance of 15 percent variation is permissible.

Table 1. Required Insulation Thicknesses

Required Insulation Thicknesses (inches)					
Service Temperature Range as Designated in Insulation Schedule at End of this Section	Nominal Pipe Diameters				
	1 inch and Less	1.25 to 2 inches	2.5 to 4 inches	5 to 10 inches	Over 10 inches
Above 200 degrees Fahrenheit	2.0	2.5	3.0	3.5	3.5
100 to 200 degrees Fahrenheit	1.5	1.5	1.5	2.0	2.5
40 to 100 degrees Fahrenheit	0.5	1.0	1.0	1.5	2.0
Below 40 degrees Fahrenheit	1.0	1.0	1.5	2.0	2.0
Heat Traced Pipes	1.0	1.0	1.0	1.5	2.0
Aeration Air Pipes	0.5	0.5	1.0	1.0	1.0

2.02 PIPE INSULATION

A. Insulation types: Provide in accordance with the insulation types listed and scheduled.

B. Insulation, Type 1:
   1. Insulation material: Closed cell elastomeric insulation.
   2. Minimum temperature range: Minus 40 degrees Fahrenheit to plus 220 degrees Fahrenheit.
   3. K factor at 75 degrees Fahrenheit: Not more than 0.27 BTU-inch/hour-square feet-degrees Fahrenheit.
   4. Fire ratings:
      a. Flame spread: 25 or less.
      b. Smoke density: 50 or less for insulation thicknesses up to 1.5 inches.
   5. Joints: Seal with manufacturer's recommended contact adhesive to form continuous water barrier.
   6. Manufacturers: One of the following or equal:
      a. Armacell, AP Armaflex.
      b. Aeroflex USA Inc., Aerocel® AC.

C. Insulation, Type 2:
   1. Insulation material: Preformed mineral fiberglass insulation made from glass fibers bonded with a thermosetting resin.
      a. In accordance with ASTM C547, Class 1.
      b. Provide with factory installed vapor barrier.
         1) Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type I.
         2) Longitudinal lap seals: Pressure-sensitive, self-sealing longitudinal lap strip with factory applied adhesive.
         3) Circumferential butt seals: 4-inch wide tape or similar properties or 4-inch wide overlap with adhesive seal.
         4) Vapor barrier permeability: 0.02 perms or lower.
         5) Vapor barrier flame spread rating: 25 or less.

2. Minimum temperature range: Minus 0 degrees Fahrenheit to plus 850 degrees Fahrenheit.
3. K factor at 75 degrees Fahrenheit: Not more than 0.23 BTU-inch/hour-square feet degrees Fahrenheit.
4. Maximum moisture absorption, volume percent: 5.
5. Manufacturers: One of the following or equal:
   a. Owens-Corning , Fiberglas™ FLEXWRAP® ASJ
   b. Johns Manville, Micro-Lok® HP.
   c. Knauf Insulation, Earthwool® Redi-Klad® 1000° Pipe Insulation.

D. Insulation, Type 3:
1. Insulation material: Rigid cellular glass in accordance with ASTM C552, Type II.
2. Temperature range: Minus 450 degrees Fahrenheit to plus 900 degrees Fahrenheit.
3. K factor at 75 degrees Fahrenheit: Not more than 0.32 BTU-inch/hour-square feet-degrees Fahrenheit.
4. Minimum average density: 7.5 pounds per cubic foot.
5. Maximum moisture absorption, volume percent: 5.
6. Minimum compressive strength: 87 pounds per square inch.
7. Moisture permeability: 0.00 perm-inch.
8. Manufacturers: One of the following or equal:
   a. Owens- Corning, Foamglas® One™.

2.03 INSULATION JACKETS

A. Jacket, Type 1:
1. Material: 28 ounces per square yard polyvinyl chloride on polyester fabric; total thickness 0.028-inch minimum.
2. Fire rating: 25 maximum flame spread, smoke developed 50 or less.
3. Color: As selected by the Engineer from manufacturer's standard colors.
4. Overlap: 1-inch minimum at joints and fittings.
5. Joint seal: Self-sealing lap tape.
6. Fittings: Factory made with full thickness insulation.
7. Manufacturers: The following or equal:
   a. Techlite® Insulation, 379 SSL Series.

B. Jacket, Type 2:
1. Material: Ultraviolet-resistant polyvinyl chloride jacketing, 20 mil minimum thickness.
2. Fire rating: 25 maximum flame spread, smoke developed 50 or less.
3. Color: White.
4. Overlap: 1-inch minimum at joints and fittings.
5. Joint seal: PVC solvent welded or adhesive as recommended by the manufacturer.
6. Fittings: Factory made with full thickness insulation.
7. Manufacturers: One of the following or equal:
   a. Johns Manville, Zeston® 2000 PVC.
   b. Proto Corp., LoSMOKE PVC.
   c. Speedline® Corp., Smoke-Safe™ PVC.

C. Jacket, Type 3:
   1. Material: Aluminum, Alloy 5005; 0.016-inch (26-gauge) minimum thickness.
   2. Overlap: Overlap circumferential joints 4 inches minimum; overlap longitudinal joints 1-inch minimum; longitudinal joints oriented to minimize water entry.
   3. Bands: 0.5-inch wide, 0.0508-inch (16-gauge) thick aluminum, same alloy as jacket or 0.0179-inch thick Type 304 stainless steel; install on 18-inch centers, uniformly spaced and at all fitting joints.
   4. Joint seal: Apply waterproof adhesive at joints and overlaps.
   5. Fittings: Custom fit of same materials.
   6. Manufacturers: One of the following or equal:
      a. Childers Products.
      b. Premetco International.

2.04 VAPOR BARRIERS

A. Vapor barrier, Type 1:
   1. Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type 1.
   2. Permeability: 0.02 perms or lower.
   3. Maximum flame spread rating: 25.
   4. Edge seal: Pressure-sensitive tape lap seal.
   5. Circumferential joints: 4-inch wide tape or 4-inch overlap with adhesive seal.

B. Vapor barrier, Type 2:
   1. Material: Mastic.
   2. Manufacturers: One of the following or equal:
      a. Benjamin Foster, No. 30-76.
      b. Insul-Coustic, No. I.C.-580.
      c. Foster Products, 36-10/46-10 Weatherite.
      d. Childers Products CP10/11 Vi-Acryl.

2.05 RELATED MATERIALS

A. Cover adhesive: Premium adhesive as recommended by the insulation cover supplier for heavy-duty service in corrosive, wet environments. Standard-duty adhesives are not permitted.

2.06 REMOVABLE INSULATING BLANKETS

A. In piping systems specified to be insulated, use removable insulating blankets for valves, meters, strainers, filters, catalytic converters, engine exhaust silencers, pumps, and other in-line piping appurtenances and equipment requiring periodic servicing, regardless of pipe size.

B. Size limits: Use removable insulating blankets for equipment and piping appurtenances 3 inches in nominal size and larger. For equipment and piping appurtenances less than 3 inches that do not require periodic servicing, insulate with molded sections of insulation or by field cutting insulation to conform to the shape of the component and to fit tightly around the component.

C. Manufacturers: One of the following, or equal:
   1. Thermal Energy Products, Inc., Energy Wrap.
   2. Accessible Products, Thermazip 2000 Jacket.
   3. Owens Corning, Temp-Mat.

D. Low temperature insulating blankets rated up to 800 degrees Fahrenheit:
   1. Use: For service temperatures up to 800 degrees Fahrenheit.
   2. Insulation: Fiberglass fiber, K factor 0.27 at 75 degrees Fahrenheit.
   3. Cover: 17-ounce fabric with both sides covered with silicone-impregnated glass cloth suitable for temperatures up to 800 degrees Fahrenheit.
   4. Cover fasteners: Use one of the following systems:
      a. Grommets in the blanket and stainless steel wire.
      b. 1-inch wide straps with stainless steel rectangular ring buckles and Velcro on strap tail.

E. High temperature insulating blankets rated up to 1,400 degrees Fahrenheit:
   1. Rated for sustained service temperatures up to 1,400 degrees Fahrenheit.
   2. Insulation: Ceramic fiber, K factor 0.50 at 600 degrees Fahrenheit, insulation material suitable for up to 2,300 degrees Fahrenheit, thickness to match adjacent piping insulation specified thickness.
   3. Cover: 17-ounce silicone impregnated fiberglass cloth suitable for temperatures up to 1,400 degrees Fahrenheit.
   4. Cover fasteners: Use one of the following systems:
      a. Grommets in the blanket and stainless steel wire.
      b. 1-inch wide straps with stainless steel rectangular ring buckles and Velcro on strap tail.

2.07 SHIPPING

A. As specified in Section 01600 - Product Requirements.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600 - Product Requirements.

B. Store insulation materials and accessories under cover and protected from moisture.

C. Handle and store insulation for use on stainless steel in accordance with ASTM C929.

3.02 PREPARATION

A. Pressure test piping and complete application of coating system before applying insulation.

B. When piping is to be heat traced, install and functionally test heat tracing before installation of insulation.

C. Before beginning installation of piping insulation, verify that the Engineer has accepted piping tests, pipe coating applications, and heat tracing tests.

3.03 INSULATION SCHEDULE

Table 2. Insulation Schedule

Service Designation[1]	Location[2]	Insulation Type[3]	Jacket Type[3]	Service Temp. °F[4]	Vapor Barrier
Aeration Air (AA)[6]	Interior	2	1	Note 4	Required
Heat Traced Pipes[7]	Exterior	1 or 2	2	N/A	Install on Type 2 insulation
Other Insulated Pipes[8]	Exterior	1 or 2	2	Note 4	Install on Type 2 insulation

Notes:

1. Refer to Piping Schedule in Section 15052 - Common Work Results for General Piping for service designations.
2. Insulation jackets are not required for interior installations that are concealed. See definitions for description of concealed locations.
3. Contractor may select from options listed.
4. Unless noted otherwise, use service temperature range provided in this table to establish insulation thickness as required by TABLE 1. Required Insulation Thicknesses.
5. Service temperature based on engine rating. Use Type I calcium silicate for exhaust temperatures up to 1,000 degrees Fahrenheit; use Type II calcium silicate for exhaust temperatures above 1,000 degrees Fahrenheit.
6. Install insulation on all aeration air piping located from the discharge of blowers to 10 feet above the slab. Insulation is not required for aeration air piping that is installed higher than 10 feet above the slab.
7. Insulate all piping systems that are specified to be heat traced.
8. Insulate all exterior above ground NPW, PW, and chemical piping unless noted otherwise on the drawings.

3.04 INSTALLATION

A. Install insulation and jacket materials in accordance with manufacturer's written instructions.

B. Apply insulation in smooth, clean manner with tight and finished smooth joints. Fit insulation tightly against surfaces. Insulate each continuous run of pipe with full-length sections of insulation with a single piece cut to length to complete the run of pipe. Do not use cut pieces or scraps to complete the installation.

C. Butt longitudinal and circumferential insulation joints firmly together.

D. Maintain the integrity of vapor barrier jacketing. Do not use staples to hold vapor barrier overlaps in place.

E. Apply sealant or cement when previous applications of adhesives and cement have thoroughly dried.

F. Apply insulation to permit expansion or contraction of pipelines without damage to insulation or jacketing.

G. Fittings:
   1. Insulate fittings by covering with mitered sections of insulation or utilize factory-made prefabricated fitting shapes.
   2. Terminate preformed pipe jackets or covering at sufficient distance from flanges to permit removal of bolts.
   3. Overlap flange and flanged fitting insulation on adjacent pipe covering by at least 2 inches.

H. Valves:
   1. Insulate valves 3 inches in nominal size and larger with removable insulating blankets.
   2. Size blanket to extend up to packing gland only so that replacement of packing does not require removal of insulating blanket.

I. Provide continuous insulation through and over pipe supports and provide protection saddles at supports.

J. Extend insulation against insulation end protection shields or covers so that insulation voids do not exist and provide watertight end seals and covers where insulation terminates.

K. Insulate pipeline strainers to permit removal of strainer basket without disturbing insulation on strainer body.

L. Provide continuous pipe insulation and covering through sleeves or openings in walls and floors. When buried pipe enters a building through a below grade wall or slab penetration, begin insulation system on interior side of penetration.

M. Apply pre-molded pipe insulation with extended legs when used on pipe traced with either tubing or electric cable type.

N. Thermally isolate all insulation closure locations (end caps, transitions, etc.) Type 1 or 2 jacket installation on piping with potential reach temperatures greater than 150 degrees Fahrenheit.

O. Apply piping identification on jackets as specified in Section 15076 - Pipe Identification.

END OF SECTION

SECTION 15084

DUCTWORK INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Internal acoustical insulation and external thermal insulation for metal air ductwork systems.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

1.04 QUALITY ASSURANCE

A. Comply with SMACNA ducting construction standards and the specified requirement, whichever is more stringent.

PART 2 PRODUCTS

2.01 EXTERNAL DUCTWORK INSULATION

A. Manufacturers: One of the following or equal:
   1. Owens Corning, SoftR Duct Wrap.
   2. Johns Manville Microlite Duct Wrap.

B. External ductwork insulation: Flexible blanket type glass fiber factory-laminated to reinforced foil Kraft vapor barrier facing with 2-inch stapling and topping flange on one edge, conforming to the following requirements:
   1. Thickness: As required to achieve the following R-values:
      a. For ducting exterior to weather protected spaces provide 2 inches {note: 2 inches correlates to R8 value} minimum thickness to meet an installed value of R8 provide additional weatherproof exterior barrier covering.

b. For interior ducting in ceiling plenums, attics or other unconditioned spaces provide 2 inches minimum thickness to meet an installed value of R8.

2. Temperature range: 40 to 250 degrees Fahrenheit.
3. Density: 1.5 pounds per cubic foot.
4. Moisture absorption: Less than 3 percent.
5. Thermal conductivity: 0.25 Btu-inch per hour per square foot per degree Fahrenheit at 75 degrees Fahrenheit.
6. Fire hazard classification in accordance with ASTM E84:
   a. Flame spread: 25.
   b. Smoke developed: 50.

C. Seaming tape: UV-resistant with properties in accordance with mechanical code as specified in Section 01410 - Regulatory Requirements.

PART 3 EXECUTION

3.01 EXTERNAL DUCTWORK INSULATION

A. Provide external ductwork insulation on round ducts carrying conditioned air pass through outdoor or unconditioned spaces, or as indicated on the Drawings.

B. Apply external duct insulation with edges tightly butted and secure by 3 wraps of 1/2-inch wide polypropylene strapping tape every 12 inches.

C. Seal seams with 4 inches wide tape with ends of the tape overlapping at least 4 inches.

D. When underside of horizontal ducts exceeds 24 inches in width, additionally secure insulation by mechanical fasteners. Install 1 mechanical fastener for every 2 square feet of duct surface.

E. Seal duct penetrations with a piece of the same facing material as the duct and install with the same vapor barrier adhesive. Extend external insulation and vapor barrier through all duct sleeves.

END OF SECTION

SECTION 15110

COMMON WORK RESULTS FOR VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic requirements for valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C111/A21.11 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe Fittings.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   2. A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   3. A536 - Standard Specification for Ductile Iron Castings.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

D. Society for Protective Coatings (SSPC):
   1. SP7 - Brush-Off Blast Cleaning.
   2. SP10 - Near-White Blast Cleaning.

1.03 DESIGN REQUIREMENTS

A. Pressure rating:
   1. Suitable for service under minimum working pressures of 150 pounds per square inch gauge.
   2. When a piping system is specified in the Piping Schedule to be tested at a pressure greater than 150 pounds per square inch gauge, provide valves for that piping system with design working pressure which is sufficient to withstand the test pressure.

B. Valve to piping connections:
   1. Valves 3 inches nominal size and larger: Flanged ends.
   2. Valves less than 3 inches nominal size: Screwed ends.
   3. Plastic valves in plastic piping:
      a. Up to 2.5 inches: Provide solvent or heat welded unions.
      b. 3 inches and above: Provide solvent or heat-welded flanges.

C. Unless otherwise noted, all liquid other than Potable Water shall be considered wastewater, or “Sewage”. AD3

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data:
   1. Submit the following information for each valve:
      a. Valve type, size, pressure rating, Cv factor.
      b. Coatings.
      c. Valve actuators:
         1) Submit information as required by Section 13447.
      d. Manual valve actuators:
         1) Information on valve actuator including size, manufacturer, model number.
      e. Certified drawings with description of component parts, dimensions, weights, and materials of construction.
      f. Certifications of reference standard compliance:
         1) Submit certification that the valves and coatings are suitable in potable water applications in accordance with NSF 61.
      g. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
      h. Factory test data, if required by individual valve specification.

C. Provide vendor operation and maintenance manual as specified in Section 01730 - Operation and Maintenance Manuals.
   1. Furnish bound sets of installation, operation, and maintenance instructions for each type of manual valve 4 inches in nominal size and larger, and all non-manual valves. Include information on valve operators.

D. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.

E. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
   1. Valves manufactured by manufacturers whose valves have had successful operational experience in comparable service.

1.06 DELIVERY STORAGE AND HANDLING

A. Protect valves and protective coatings from damage during handling and installation; repair coating where damaged.

PART 2 PRODUCTS

2.01 MATERIALS

A. Stainless steel: In accordance with ASTM A480, Type 316, or Type 304, UNS Alloy S31600 or S30400.

B. Valve and operator bolts and nuts:
   1. Fabricated of stainless steel for the following installation conditions:
      a. Submerged in sewage or water.
      b. In an enclosed space above sewage or water.
      c. In structures containing sewage or water, below top of walls.
      d. At openings in concrete or metal decks.
   2. Where dissimilar metals are being bolted, use stainless steel bolts with isolation bushings and washers.
   3. Underground bolts: Low-alloy steel in accordance with AWWA C111/A21.11.

C. Bronze and brass alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacture of valve parts; UNS Alloy C83600 or C92200 unless specified otherwise.

D. Valve bodies: Cast iron in accordance with ASTM A126, Class 30 minimum or ductile iron in accordance with ASTM A536, Grade 65-45-12 minimum unless specified otherwise.

2.02 INTERIOR PROTECTIVE LINING

A. When specified in the particular valve specification, provide valves with type of protective lining specified in the particular valve Specification.

B. Apply protective lining to interior, non-working surfaces, except stainless steel surfaces.

C. Lining types:
   1. Fusion bonded epoxy:
      a. Manufacturers: The following or equal:
         1) 3-M Company, ScotchKote 134; certified to NSF 61 for drinking water use.
      b. Clean surfaces in accordance with SSPC SP 7 or SP 10, as recommended by epoxy manufacturer.
      c. Apply in accordance with manufacturer's published instructions.
      d. Lining thickness: 0.010 to 0.012-inch, except that:
         1) Lining thickness in grooves for gaskets: 0.005-inch.
         2) Do not coat seat grooves in valves with bonded seat.
      e. Quality control:
         1) Lining thickness: Measured with a non-destructive magnetic type thickness gauge.
         2) Verify lining integrity with a wet sponge-testing unit operating at approximately 60 volts, or as recommended by the lining manufacturer.
         3) Consider tests successful when lining thickness meets specified requirements and when no pinholes are found.
         4) Correct defective lining disclosed by unsuccessful tests, and repeat test.
         5) Repair pinholes with liquid epoxy recommended by manufacturer of the epoxy used for lining.
   2. High solids epoxy:
      a. Product equivalent to high solids epoxy specified in Section 09960 - High-Performance Coatings.

1) Certified in accordance with NSF 61 for drinking water use.
2) Interior: Coat valve interior with manufacturer's equivalent high performance high solids epoxy coating system with a certifiable performance history for the service conditions and as approved by the Engineer. Manufacturer shall provide for approval, coating information sufficient to allow Engineer to assess equivalence to the specified high solids epoxy coating specified in Section 09960 - High-Performance Coatings.

b. Clean surfaces to meet SP-7 or SP-10, or as recommended by coating manufacturer.

c. Quality control: After coating is cured, check coated surface for porosity with a holiday detector set at 1,800 volts, or as recommended by coating manufacturer.
   1) Repair holidays and other irregularities and retest coating.
   2) Repeat procedure until holidays and other irregularities are corrected.

2.03 UNDERGROUND VALVES

A. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.

B. Coating and wrapping:
   1. After installation, encase valves in 2 layers of polyethylene wrap as specified for ductile iron piping in Section 15211 - Ductile Iron Pipe: AWWA C151.
      a. Ascertain that polyethylene wrapping does not affect operation of valve.

2.04 STEAM VALVES

A. Valves in steam or steam condensate piping: Ductile iron body in accordance with ASTM A536, Grade 65-45-12 minimum or cast steel or forged steel.

2.05 VALVE BOXES

A. Provide cast-iron valve boxes at each buried valve to access valve and valve operators.

B. Do not support boxes on valve, valve operator, or pipe.

C. Boxes:
   1. 2-piece, fabricated of cast iron; provide cover, with asphalt varnish or enamel protective coating.
   2. Adjustable to grade, install centered around the upper portions of the valve and valve operator.

D. Manufacturers: One of the following or equal:
   1. Tyler Pipe Industries, Inc.
   2. Neenah Foundry Co.

2.06 VALVE OPERATORS

A. Valve operator "Open" direction: Open counterclockwise.

B. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels.

C. Provide manually operated valves located not more than 6 feet above the operating level with tee handles, wrenches, or handwheels.
   1. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
   2. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.

D. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels.
   1. Chains: Sufficient length to reach approximately 4 feet above the operating level.
   2. Where chains constitute a nuisance or hazard to operating personnel, provide holdbacks or other means for keeping the chains out of the way.

E. Provide an operator shaft extension from valve or valve operator to finished grade or deck level when buried valves, and other valves located below the operating deck or level, are specified or indicated on the Drawings to be key operated; provide 2 inches square AWWA operating nut, and box and cover as specified, or a cover where a box is not required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Preparation prior to installation:
   1. Install valves after the required submittal on installation has been accepted.
   2. Determine after flanged valves and flanged check valves are selected, the face-to-face dimensions of flanged valves and flanged check valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

B. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by Contractor.
   2. Where such additional valves are required as a result of a substitution or change initiated by Contractor.

C. Valve and actuator orientation:
   1. Contractor shall coordinate with valve supplier final orientation of valve and actuator assembly based on Contractor's selection of equipment manufacturers and the valve and piping arrangement as indicated on the Drawings.
      a. Contractor shall rotate valve and/or actuator mounting orientation as specified in this Section unless otherwise indicated on the Drawings.
   2. Install valves with their stems in vertical position above the pipe, except as follows:
      a. Butterfly valves, gate valves aboveground, globe valves, ball valves, and angle valves may be installed with their stems in the horizontal position.
      b. Install buried plug valves with geared operators with their stems in a horizontal position.
   3. Install valves so that handles clear obstructions when the valves are operated from fully open to fully closed.

D. Place top of valve boxes flush with finished grade or as otherwise indicated on the Drawings.

E. Valves with threaded connections:
   1. Install valves by applying wrench on end of valve nearest the joint to prevent distortion of the valve body.
   2. Apply pipe joint compound or Teflon™ tape on external (male) threads to prevent forcing compound into valve seat area.

F. Valves with flanged connections:
   1. Align flanges and gasket carefully before tightening flange bolts.
   2. When flanges are aligned, install bolts and hand tighten.
   3. Tighten nuts opposite each other with equal tension before moving to next pair of nuts.

G. Valves with soldered connections:
   1. Do not overheat connection to prevent damage to resilient seats and metal seat rings.
   2. Position valves in full open position before starting soldering procedure.
   3. Apply heat to piping rather than to valve body.

3.03 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960 - High-Performance Coatings.
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

C. As specified elsewhere for specific valve types, sizes or actuators.
   1. Source testing.
   2. Manufacturers on site services for Owner Training, Installation Testing, Functional Testing, and during the Process Operational Period.

END OF SECTION

[AD3] Addendum No. 3

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SECTION 15111

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Ball valves.

B. As specified in Section 15110 - Common Work Results for Process Valves - Common Work Results for Valves, Section 13446 - Manual Actuators, and Section 13447 - Electric Motor Actuators.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA):
   1. C507 - Standard for Ball Valves 6 Inch Through 48 Inch.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   3. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Metal body ball valves on metallic pipelines.
   2. Plastic body ball valves on plastic pipelines.

B. Do not use metal body ball valves in sodium hypochlorite or sodium bisulfite systems.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15110 - Common Work Results for Process Valves - Common Work Results for Valves:
   1. Metal body ball valves: 6 inches and larger only: Submit affidavit of compliance in accordance with AWWA C507.
   2. Operation and maintenance manual.

C. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 – Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 METAL BODY BALL VALVES, LESS THAN 6-INCH SIZE

A. Manufacturers: One of the following, or equal:
   1. Conbraco Industries, Inc., Apollo Valves.
   2. Flow-Tek, Inc.
   3. Metso Automation/Jamesbury.
   4. NIBCO, Inc.

B. General:
   1. Type: Non-lubricated, full port and capable of sealing in either direction.
   2. End connections:
      a. Threaded or solder ends for sizes 3-inch and smaller.
      b. Class 150 flanged for sizes larger than 3 inches.
         1) Flanges: In accordance with ASME B16.1 standards.
   3. Stem packing: Manually adjustable while valve is under pressure.
   4. Shafts:
      a. Rigidly connected to the ball by a positive means.
         1) Design connection to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
   5. Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
   6. Temperature limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.

C. Materials:
   1. Valves in copper lines: Bronze body.
   2. Valves in steel and ductile iron piping: Ductile iron or cast steel body.
   3. Valves in stainless steel piping: Stainless steel body, material type to match piping material as specified in Section 15052 - Common Work Results for General Piping - Common Work Results for General Piping.
   4. Ball: Type 304 or 316 stainless steel, Type 316 in digester gas applications.
   5. Seats: PTFE.
   6. Stem seals: PTFE or Viton™.
   7. Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
   8. Valves for combustible fluid applications (digester gas, natural gas, fuel oil, etc.) must be of fire safe design.

2.02 PLASTIC BODY BALL VALVES

A. Manufacturers: One of the following or equal:
   1. Asahi America.
   2. Chemtrol Division, NIBCO, Inc.
   3. Georg Fischer Piping Systems.
   4. Hayward Flow Control.
   5. Plast-O-Matic Valves, Inc.

B. General:
   1. Type: Non-lubricated and capable of sealing in either flow direction.
   2. End connections: True union; solvent or heat welded to piping.
   3. Operator handle: Lever.

C. Materials:
   1. Body: Polyvinyl chloride (PVC).
   2. Ball: Polyvinyl chloride (PVC).
   3. Seats: PTFE (Teflon™).
   4. O-rings: EPDM.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Special techniques:
   1. PVC ball valves for hypochlorite service:
      a. Provide valve with factory drilled 0.125-inch hole in the upstream side of the ball.
      b. Provide an engraved plastic tag permanently attached to the valve stem stating "One side of ball drilled for hypochlorite service".

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960 - High-Performance Coatings - High-Performance Coatings.
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.03 COMMISSIONING

A. As specified in Section 01756 – Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test, as specified in Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 15112

BUTTERFLY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Butterfly valves:
   1. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C504 - Rubber-Seated Butterfly Valves.
   3. C540 - Standard for Power-Actuating Devices for Valves and Sluice Gates.
   4. C550 - Protective Interior Coatings for Valves & Hydrants.
   5. C606 - Standard for Grooved and Shouldered Joints.

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for Higher-Temperature Service.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   5. A395 - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
   6. A479 - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   7. A515 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate - and Higher-Temperature Service.
   8. A516 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower-Temperature Service.
   9. A536 - Standard Specification for Ductile Iron Castings.
   10. A564 - Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
   11. A582 - Standard Specification for Free-Machining Stainless Steel Bars.

12. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
13. A890 - Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application.
14. B462 - Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
15. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
16. B691 - Standard Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Rod, Bar, and Wire.
17. D429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrate.

D. Compressed Gas Association (CGA):
   1. Standard G-4.1 - Cleaning Equipment for Oxygen Service.

E. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components - Health Effects.

F. United States Code of Federal Regulations (CFR):
   1. 21 - Food and Drugs.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. General purpose AWWA butterfly valves:
      a. Design standard: Provide valves designed and manufactured in accordance with AWWA C504.
      b. Class:
         1) Provide butterfly valves in accordance with AWWA Class 150B, unless otherwise specified.
         2) Provide butterfly valves in accordance with AWWA Class 250B in piping systems with test pressure greater than 150 pounds per square inch and less than 250 pounds per square inch.
   2. High pressure butterfly valves:
      a. Piping systems designed for operating pressures greater than 250 pounds per square inch and less than 450 pounds per square inch: Provide ASME B16.5, Class 300 high pressure valves.
   3. Industrial class butterfly valves:
      a. Industrial class butterfly valves capable of 150 pounds per square inch leak tight shut off.
      ~~a.~~b. Unless noted otherwise, all butterfly valves for air service shall be industrial class butterfly valves. AD3
   4. Stainless steel butterfly valves:
      a. Stainless steel butterfly valves capable of a minimum of 100 pounds per square inch leak tight shut off and with special cleaning, packaging, and handling.

B. Usage:
   1. Provide and install butterfly valve types as outlined in the Butterfly Valve Application Schedule at the end of this Section.

C. Design requirements for all butterfly valves with power actuating devices:
   1. Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C540, using the following values:
      a. Maximum water velocity: 16 feet per second with valve fully open.
      b. Maximum pressure differential across the closed valve equal to the pressure class designation.
      c. Coefficient for seating and unseating torque, dynamic torque, and bearing friction in accordance with valve manufacturer's published recommendations.
   2. Valve disc: Seat in an angular position of 90 degrees to the pipe axis and rotate an angle of 90 degrees between fully open and fully closed positions:
      a. Do not supply valves with stops or lugs cast with or mechanically secured to the body of the valve for limiting the disc travel.
   3. Unacceptable thrust bearings: Do not provide valves with thrust bearings exposed to the fluid in the line and consisting of a metal bearing surface in rubbing contact with an opposing metal bearing surface.

D. Performance requirements:
   1. Tight shutoff at the pressure rating of the valve with pressure applied in either direction.
   2. Suitable for the following service conditions:
      a. Throttling.
      b. Frequent operation.
      c. Operation after long periods of inactivity.
      d. Installation in any position and flow in either direction.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: 15110 - Common Work Results for Valves.
   1. For general purpose AWWA butterfly valves, include description of the method of attachment of the disc edge to the valve disc.
   2. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves comply with all provisions in accordance with AWWA C550.
   3. Certification, for valves and coatings in contact with potable water, that the products used are suitable for contact with drinking water in accordance with NSF Standard 61.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL PURPOSE AWWA BUTTERFLY VALVES

A. Manufacturers: One of the following or equal:
   1. DeZURIK/Sartell Model BAW.
   2. Henry Pratt Co.
   3. Crispin Valves

B. Valve body:
   1. Material: Cast iron, ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65-45-12.
   2. Body design:
      a. Flanged body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Flanges: In accordance with ASME B16.1 Class 125 flanges for Class 150B valves, in accordance with ASME B16.1 Class 250 flanges for Class 250B valves.
      b. Mechanical joint body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Mechanical joint design: In accordance with AWWA C110.
         3) When mechanical joint body valves are used, incorporate valve into thrust restraint analysis as specified in Section 15211 - Ductile Iron Pipe: AWWA C151. Utilize test pressure on one side of valve and zero pressure on the opposite side of the valve. Restrain pipe joints on both sides of valve as determined by thrust analysis calculations.
      c. Grooved end body valves:
         1) Usage: Butterfly valves with grooved ends may be used in piping systems specified in the Piping Schedule to have grooved end joints. Comply with additional limitations specified in the Butterfly Valve Application Schedule.
         2) Grooved end joint design: In accordance with AWWA C606.

C. Disc:
   1. Material: Cast iron or ductile iron with Type 316 stainless steel edge that matches seat in valve body.
   2. Secure valve disc to shaft by means of smooth-sided, taper or dowel pins, Type 316 stainless steel, or Monel.
   3. Extend pins through shaft and mechanically secure in place.

D. Shaft and bearings:
   1. Shaft design:
      a. Valves 20-inches and less: 1-piece, through disc design.
      b. Valves greater than 20-inch size: 2-piece, stub shaft design.
   2. Shaft seal: Vee type, chevron design.
   3. Shaft material for Class 150B valves: Type 316 stainless steel, ASTM A276.

4. Shaft material for Class 250B valves: Type 17-4 pH stainless steel, ASTM A564.
5. Shaft bearings: Self-lubricating sleeve type:
    a. Valves 20 inches and less: Nylatron.
    b. Valves greater than 20-inch size: Teflon™ with stainless steel or fiberglass backing.

E. Seats:
1. Seat materials:
    a. In low-pressure air applications: EPDM.
    b. In all other applications: EPDM.
2. For valves 20 inches in nominal size and smaller, bond or vulcanize seat into the valve body.
3. For valves 24 inches in nominal size and larger, retain seats mechanically or by adhesive:
    a. Mechanical retainage: Retain seat by a clamping ring with segmented clamping ring locks with adjusting locking screws.
        1) Clamping ring, ring locks, and adjusting locking screws: Type 316 stainless steel.
        2) Provide means to prevent ring locks and screws used to retain seats from loosening due to vibration or cavitation.
    b. Adhesive retainage: Inset the seat within a groove in the valve body and retain in place with epoxy injected behind the seat so that the seat expands into the body.
    c. Do not provide valves with seats retained by snap rings or spring-loaded retainer rings.
4. Resilient seat: Withstand 75 pound per inch pull when tested in accordance with ASTM D429, Method B.

F. Valve packing:
1. Valves 4 inches to 48 inches nominal size: Self-adjusting V-type packing or chevron-type packing. NBR or EPDM to match seat material.
2. Valves 54 inches nominal size and larger: Adjustable V-type packing with bronze packing gland or self-adjusting V-type packing. NBR or EPDM to match seat material.

2.02 INDUSTRIAL CLASS BUTTERFLY VALVES

A. Manufacturers: One of the following or equal:
1. SPX/DeZURIK Style BOS.
2. Tyco-Keystone Figure GR series.

B. Valve body:
1. Pressure rating: 150 pounds per square inch, minimum.
2. Material: Cast iron, ASTM A126, Class B or Ductile Iron, ASTM A395, Grade 60/40/18.
3. Body design: Lugged style body with drilled and tapped boltholes in accordance with ASME B16.1, Class 125 and Class 150 flange drilling dimensions.

C. Disc:
   1. Materials:
      a. Air and water service: Cast iron, ASTM A126, Class B or Ductile Iron, ASTM A536, Grade 65/45/12 or Type 316 stainless steel, ASTM A351, Grade CF8M.
      b. Natural gas and digester gas service: Type 316 stainless steel, ASTM A351, Grade CF8M.
   2. Disc edge: Nickel-plated when cast iron or ductile iron disc is used.

D. Shaft and bearings:
   1. Shaft: Type 316 stainless steel, ASTM A276 or Type 416 stainless steel, ASTM A582.
   2. Shaft bearings: Self-lubricating sleeve type, Teflon™ with stainless steel or fiberglass backing.

E. Disc pins: Secure valve disc to shaft by means of solid, smooth-sided, taper or dowel pins, Type 316 stainless steel:
   1. Extend pins through shaft and mechanically secure in place.

F. Seats:
   1. Material:
      a. Natural gas and digester gas applications: Neoprene or Buna N.
      b. All other applications: EPDM.
   2. Seat retention ring, if used on larger sizes: Type 316 stainless steel or bronze, ASTM B584, with stainless steel fasteners. For all such valves, bond the seat to the retention ring.

G. Valve shaft packing:
   1. Natural gas and digester applications: Neoprene or Buna N.
   2. All other applications: EPDM or Teflon™.

2.03 COATING

A. Shop coat interior and exterior metal surfaces of valves, except as follows:
   1. Interior machined surfaces.
   2. Surfaces of gaskets and elastomeric seats and stem seals.
   3. Bearing surfaces.
   4. Stainless steel surfaces and components.

B. Coating material for potable water applications:
   1. Formulate interior coating material from materials in accordance with CFR 21, AWWA C550, and NSF 61.
   2. Submit affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves in accordance with CFR 21, AWWA C550, and NSF 61.

C. Interior surfaces:
   1. Interior surfaces, except for valves used in low-pressure air service: High solids epoxy.
   2. Interior surfaces of valves used in low-pressure air service: High temperature coating for range of 150 to 350 degrees Fahrenheit.

D. Exterior surfaces:
   1. Exterior surfaces of valves, actuators, and accessories coating in accordance with Section 09960 - High-Performance Coatings with the following coating types:
      a. Submerged valves: High solids epoxy.
      b. Buried valves: Coal tar epoxy.
      c. Other valves: High solids epoxy with polyurethane topcoat.
   2. Polished and machined surfaces: Apply rust-preventive compound,
      a. Manufacturers: One of the following or equal:
         1) Houghton, Rust Veto 344.
         2) Rust-Oleum, R-9.

E. Coating materials:
   1. High solids epoxy and coal tar epoxy:
      a. Products: As specified in Section 09960 - High-Performance Coatings:
         1) Coating product in contact with potable water must be in accordance with AWWA C550 and NSF 61.
   2. High temperature coating: As specified in Section 09960 - High-Performance Coatings and in accordance with AWWA C550.
   3. Rust-preventive compound:
      a. Manufacturers: One of the following or equal:
         1) Houghton, Rust Veto 344.
         2) Rust-Oleum, R-9.

F. Field applied coatings of valve exterior:
   1. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coatings.
      a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves with valve shafts horizontal, unless a vertical shaft is required to suit a particular installation, and unless a vertical shaft is indicated on the Drawings.

B. Install pipe spools or valve spacers in locations where butterfly valve disc travel may be impaired by adjacent pipe lining, pipe fittings, valves, or other equipment.

3.02 BUTTERFLY VALVE APPLICATION SCHEDULE

A. Acceptable butterfly valve types and body styles are listed in the Butterfly Valve Application Schedule provided at the end of this Section. Furnish and install butterfly valves in accordance with this Schedule.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test, as specified in Section 15110 - Common Work Results for Valves.

BUTTERFLY VALVE APPLICATION SCHEDULE	
Valve Type and Style	**Acceptable Applications**
General Purpose AWWA Butterfly Valves - Flanged Body Design.	Aboveground or submerged in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service. - May be used in buried applications when required by the specified piping system.
General Purpose AWWA Butterfly Valves - Mechanical Joint Body Design.	Buried in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service.
General Purpose AWWA Butterfly Valves - Lugged Body Design.	Aboveground in the following service applications only: - Aeration Air Systems.
General Purpose AWWA Butterfly Valves - Wafer (not lugged) Body Design.	Not allowed.
General Purpose AWWA Butterfly Valves - Grooved End Body Design.	Aboveground, in sizes 20 inches and less, with piping system test pressure less than 100 psi, and in the following service applications only: - Acceptable in all service applications, except oxygen and ozone service, where piping for that service is specified in the Piping Schedule to have grooved end joints.
High Pressure Butterfly Valves - Flanged Body Design.	Service applications with piping system test pressure greater than 250 psi. Acceptable in aboveground and buried installations.
High Pressure Butterfly Valves - Wafer or Lugged Wafer Body Design.	Not allowed.

BUTTERFLY VALVE APPLICATION SCHEDULE	
Valve Type and Style	**Acceptable Applications**
Industrial Class Butterfly Valves - Lugged Body Design.	Aboveground in the following service applications only: - Aeration Air Systems. - Natural Gas Systems. - Digester Gas Systems. - Chilled and Hot Water Systems.
Industrial Class Butterfly Valves - Wafer (not lugged) Body Design.	Not allowed.
Stainless Steel Butterfly Valves - Lugged Body Design.	Aboveground in the following service applications only: - Oxygen Systems. - Ozone Systems.
Stainless Steel Butterfly Valves - Wafer (not lugged) Body Design.	Not allowed.

END OF SECTION

[AD3] Addendum No. 3

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SECTION 15114

CHECK VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Check valves.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Inch Standard.

B. American Water Works Association (AWWA):
   1. C508 - Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A313 - Standard Specification for Stainless Steel Spring Wire.
   3. A536 - Standard Specification for Ductile Iron Castings.
   4. B582 - Standard Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet, and Strip.
   5. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Check valves: When not otherwise specified as indicated on the Drawings, provide check valves suitable for service as follows:
      a. In either horizontal or vertical position.
      b. Suitable for service working pressures up to 150 pounds per square inch gauge.

B. Unless otherwise noted, all liquid service check valves shall be angled swing check valves.

~~B.~~C. Unless otherwise noted, all air service check valves shall be flapper-type check valves. AD3

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 ANGLED SWING CHECK VALVES

A. The valves shall be designed, manufactured, and tested in accordance with American Water Works Association Standards ANSI/AWWA C508.

B. Valves shall be provided with flanges in accordance with ANSI B16.1, Class 125.

C. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The seating surface shall be on a 45-degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator, air cushion, or hydraulic cushion without special tools or removing the valve from the line.

D. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator. The disc shall be of one-piece construction, precision molded with an integral o-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for 25 years. Non-slam closing characteristics shall be provided through a short 35-degree disc stroke and a disc accelerator.

E. The disc accelerator shall be of one-piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place by being captured between the cover and disc. It shall be formed with a large radius to allow smooth movement over the disc surface.

F. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified.

G. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage.

H. Materials:
   1. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 Class B for 30 inches and larger.
   2. The disc shall be precision molded Viton.
   3. The disc accelerator shall be type 302 stainless steel.
   4. The interior of the valve shall be coated with an ANSI/NSF 61 approved fusion bonded epoxy coating.

I. Options:
   1. A screw type backflow actuator shall be provided to allow opening the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a lead-free bronze bushing. The backflow device shall be of the rising stem type to indicate position. A stainless steel T-handle shall be provided for operation.
   2. A mechanical indicator shall be provided to provide disc position indication. The indicator shall have continuous contact with the disc under all operating conditions to provide disc position indication at all times.

J. Manufacturers and Products: The manufacturer shall demonstrate a minimum of 5 years experience in the manufacture of resilient, flexible disc check valves with air and hydraulic cushions.
   1. Val-Matic Surgebuster Series #7200;
   2. Approved equivalent product.

2.02 FLAPPER-TYPE CHECK VALVES

A. Manufacturers: One of the following or equal:
   1. Crane Co., Crane Valve Group, Duo Chek Check Valves.
   2. Techno Corp., equivalent product.
   3. APCO Model 9000.

B. Valve design:
   1. Dual valve plates with replaceable elastomeric member which acts as both a hinge and a seal.
   2. Elastomeric member secured to valve plates with clamping plates and fasteners.
   3. Full port, seatless design. Eliminate leakage when valve plates are fully closed with elastomeric member in full contact with interior surface of valve port.
   4. Wafer-style valve body.

C. Materials:
   1. Body: Cast iron.
   2. Valve plates: Type 316 stainless steel. Stainless-faced iron casting not acceptable.
   3. Seal: Viton™.

2.03 PLASTIC BALL CHECK VALVES

A. Manufacturers: One of the following or equal:
   1. Chemtrol Division of Nibco.

2. Georg Fischer Piping Systems.
3. Plast-O-Matic Valves, Inc.
4. Hayward Flow Control.

B. Valves: Ball type:
1. Material: Polyvinyl chloride.
2. End connection: Double-or single-union-type.
3. Seals: Viton™.

C. Valve body material:
1. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), Polypropylene (PP) or polyvinylidene fluoride (PVDF), as best suited for each individual service condition.

D. Union connections material:
1. NPT or socket ends conforming to ASME B16.5 pipe flanges and flange fittings, Class 150.

E. Seats and seals material:
1. EPDM, Buna-N, or Viton™.

F. Maximum inlet pressure rating:
1. PVC, CPVC, or PVDF: 150 pound per square inch at 77 degrees Fahrenheit.
2. PP: 100 pounds per square inch at 77 degrees Fahrenheit.

2.04 DUCK BILL CHECK VALVES

A. Manufacturers: One of the following or equal:
1. Red Valve Company - Tideflex

B. Valves: Duckbill Type Series 35
1. Valve Material: Rubber/Elastomer
2. Retaining Rings: Galvanized steel
3. End Connection: Flanged

C. Valve Body Material:
1. Elastomer/Rubber

D. Union Connections Material
1. Flange with drillings conforming to ANSI B16.5 and B16.47, Class 150

E. Back pressure rating:
1. Minimum 0 psi
2. Maximum 2.5 psi

PART 3 EXECUTION

3.01 INSTALLATION

A. Flapper-type check valves:
1. Install with proper orientation of flow direction arrow on valve body.
2. When installed in horizontal pipelines, mount with shaft on vertical locations.

3. When mounted in a vertical pipeline, directly downstream of an elbow, mount with the shaft perpendicular to the outermost portion of the elbow.
4. Mount on downstream side of discharge silencer when used on positive displacement and centrifugal blowers.

B. Duckbill check valves:
1. Install with bill in the vertical position.
2. The valve end with the rubber flange face should be installed on the pressure side of the system using the split backup rings provided.
3. The sleeve split should be installed facing downstream, with the split in the vertical position.
4. The installation bolt torque on the end of the flange bolts shall be in accordance with manufacturers recommendations.

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coatings.
1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
1. Provide certificates:
a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
1. Valves:
a. Test witnessing: Witnessed.
b. Conduct pressure and leak test, as specified in Section 15956 - Piping Systems Testing.

END OF SECTION

[AD3] Addendum No. 3

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SECTION 15115

GATE, GLOBE, AND ANGLE VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Gate, globe, angle, plug disc and plain hose valves, and yard hydrants.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 inch Standard.
   2. B16.47 - Large Diameter Steel Flanges: NPS 26 through NPS 60 inch Standard.
   3. B36 - Stainless Steel Pipe.

B. American Water Works Association (AWWA):
   1. C515 - Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Services.
   2. C 550 - Protective Interior Coatings for Valves and Hydrants.

C. ASTM International (ASTM):
   1. B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals: For valves larger than 16 inches:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

B. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of valves comply in accordance with all provisions of AWWA C550.

PART 2 PRODUCTS

2.01 GATE VALVES

A. Gate valves aboveground:
   1. Valves less than 3 inches in size for clean water and air service:
      a. Manufacturers: One of the following or equal:
         1) Crane, Figure 431.
         2) Jenkins, Figure 47.
         3) Lunkenheimer Co., Figure 2151.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Manufacturer's standard bronze, solid wedge disc, rising stem, screwed end, Class 150 pounds.
   2. Valves 3 inches in size and larger:
      a. Manufacturers: One of the following or equal:
         1) M&H/Kennedy Valve Co.
         2) Mueller.
         3) American Flow Control, Series 2500.
      b. Design:
         1) Size, material, configuration: Indicated on the Drawings.
         2) Resilient wedge type in accordance with AWWA C515.
         3) Flange, iron body, and bonnet rated for 200 pound working pressure.
            a) Provide o-ring seal between valve body and bonnet.
         4) Ductile or cast iron wedge encapsulated in nitrile rubber and capable of sealing in either flow direction.
         5) Bronze stem with double or triple o-ring or braided packing stem seals.
         6) Rising stem configuration with handwheel diameter sized to allow opening of valve with no more than a 40-pound pull.
         7) Coat interior and exterior surfaces of valve body and bonnet with fusion-bonded epoxy in accordance with AWWA C550.

B. Gate valves underground:
   1. Manufacturers: One of the following or equal:
      a. M&H/Kennedy Valve Co.
      b. Mueller Co.
      c. American Flow Control.
   2. Design:
      a. Size, material, configuration: Indicated on the Drawings.
      b. Resilient wedge type in accordance with AWWA C515.
      c. Stem:
         1) Iron body, resilient seat, non-rising stem, double o-ring stem seal.
         2) Rising stem configuration with handwheel diameter sized to allow opening of valve with no more than a 40-pound pull.
      d. Ductile or cast iron wedge encapsulated in nitrile rubber and capable of sealing in either flow direction.
      e. Bronze stem with double or triple o-ring or braided packing stem seals.
      f. Coat interior and exterior surfaces of valve body and bonnet with fusion-bonded epoxy in accordance with AWWA C550.
      g. Valve operator: Provide standard AWWA 2-inch operating nut, matching valve key, and valve box for operating stem.

C. Steam and condensate gate valves:
   1. Valves 3 inches and smaller in size:
      a. Manufacturers: One of the following or equal:
         1) Crane, No. 428.
         2) Jenkins, Figure 47U.
         3) Lunkenheimer Co., Figure 2127.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Bronze, screwed, rising stem, solid wedge, screwed bonnet, suitable for service under pressures equal to and less than 125 pounds per square inch gauge, steam working pressure (SWP).
   2. Valves larger than 3 inches in size:
      a. Manufacturers: One of the following or equal:
         1) Crane No. 465-1/2.
         2) Jenkins, Figure 651C.
         3) Lunkenheimer Co., Figure 1430.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Suitable for service under pressures equal to and less than 125 pounds per square inch gauge, steam working pressure (SWP), flanged, iron body, bronze mounted, solid wedge, outside screw and yoke (OS&Y).

D. Knife gate valves:
   1. Manufacturers: One of the following or equal:
      a. DeZurick SPX, KGL.
      b. ITT Fabri-Valve, C37.
   2. Design:
      a. Size and configuration: Indicated on the Drawings.
      b. Suitable for service under pressures equal to and less than 150 pounds per square inch gauge
      c. Full round port, metal or resilient seated, raised face design.
      d. Flanged wafer design drilled and tapped to ASME Class 125/150 standard. Face-to-face dimension shall meet MSS SP-81 for knife gate valves ASME B16.5 class 150, 2 to 24 inches or ASME 16.47 Series A class 150, 26 to 48 inches
      e. Rounded gate with beveled edge, finish-ground to 32 RMS, maximum, on both sides. The bottom edge shall have a beveled knife edge.
      f. Body to incorporate guides and jams to assist in seating.
      g. Packing shall consist of multiple layers of packing.
      h. Materials:
         1) Body: Cast or ductile iron or cast steel, with Type 316 stainless steel lining or cast Type 316 stainless steel or 2205 Duplex.
         2) Wetted components (including gate): Type 316 stainless steel or 2205 Duplex.
         3) Seat: Metal or NBR, EPDM, CR, Viton™.
         4) Yoke sleeve: Acid resisting bronze or aluminum bronze.
         5) Packing: PTFE.
         6) Packing gland: Match valve body material.
         7) Yoke: Type 304 stainless steel.
         8) Fasteners: Shall be stainless steel.
      i. Outside screw and yoke (OS&Y) with handwheel operator.

2.02 GLOBE AND ANGLE VALVES

A. General purpose globe and angle valves:
   1. Valves 3 inches and smaller:
      a. Manufacturers: One of the following or equal:
         1) Except in welded steel piping:
            a) Crane, No. 1 Globe or No. 2 Angle.
            b) Lunkenheimer Co. Figure No. 2140 Globe or No. 2141 Angle.
         2) In Welded steel piping:
            a) Crane, No. 351.
            b) Lunkenheimer Co., Figure No. 1123; or equal with flanged ends.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Valve: Class 125 threaded ends, rated for 250 degrees Fahrenheit at pressure of 170 pounds per square inch.
   2. Valves larger than 3 inches:
      a. Manufacturers: One of the following or equal:
         1) Crane, No. 351.
         2) Lunkenheimer Co., Figure No. 1123.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
   3. Plug disc globe valves: for throttling or for severe service.
      a. Manufacturers: One of the following or equal:
         1) Crane, No. 212P or No. 384P.
         2) Lunkenheimer Co., 72-PS or 73-PS1.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Material: Iron body stainless steel trimmed plug type seat and disc.

2.03 HOSE VALVES AND YARD HYDRANTS

A. Hose valves:
   1. Manufacturers:
      a. Globe threaded valve: One of the following or equal:
         1) Crane, No. 7TF.
         2) Stockham, Figure No. B22T.
      b. Angle threaded valve: One of the following or equal:
         1) Crane, No. 17TF.
         2) Stockham, Figure No. B222T.
   2. Design:
      a. Size and configuration: Indicated on the Drawings.
      b. Valve: Globe or angle valve with threaded ends.
      c. Disc: Renewable, made of Teflon™ or Buna-N.
      d. Threaded ends rated for a pressure of 200 pounds per square inch.

B. Freezeless yard hydrant:
   1. Manufacturers: One of the following or equal:
      a. Kupferle Foundry Co.
         1) #1 Total Eclipse Yard Hydrant - 3/4-inch and 1 inch.
      b. Murdock Company:
         1) #M-75 - 3/4-inch or #M100 - 1 inch.

c. Zurn Company:
1) #1385 - 3/4-inch or 1 inch.

2. Design:
a. Self-draining, non-freezing, compression type.
1) Inlet connection size: Indicated on the Drawings.
2) Outlet connection size: Indicated on the Drawings.
3) Materials:
a) Exterior casing pipe material: Indicated on the Drawings.
b) Interior operating rod material: Indicated on the Drawings.
c) Casing guard material: Indicated on the Drawings.
d) Principal interior operating parts material: brass and/or bronze and removable from yard hydrant for servicing without excavation.
4) Provide 4 Spoke, Ball Wheel Handle operated.

C. Freezeless post hydrants:
1. Manufacturers: The following or equal:
a. Kupferle Foundry Co.:
1) #2 Eclipse Post Hydrant.
b. Mueller Co.:
1) #A-411 Post Hydrant.
c. Murdock Co.:
1) #M-200 Post Hydrant.
2. Design:
a. Self-draining, non-freezing, compression type with a 2-3/16-inch valve opening.
b. Inlet connection size: Indicated on the Drawings.
c. Outlet connection size: Indicated on the Drawings.
d. Materials:
1) Exterior casing pipe material: Indicated on the Drawings.
2) Interior operating rod material: Indicated on the Drawings.
3) Top stock material: Indicated on the Drawings.
4) Principal interior operating parts material: Brass and/or bronze and removable from hydrant for servicing without excavation.
e. Provide 1-1/2-inch pentagon operating nut operated by a hydrant wrench or 10-inch hand wheel:
1) Manufacturers: The following or equal:
a) Kupferle Foundry Co.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount yard hydrants on minimum 1-inch supply pipe or size indicated on the Drawings.

B. Mount Post hydrants on minimum 2-inch supply pipe or size indicated on the Drawings.

C. Set yard and post hydrants in 4 cubic feet of 3/4-inch minimum crushed stone surrounding valve body to allow for proper drainage.
1. Install in accordance with AWWA recommendations for hydrants.

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coatings.
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services: For valves larger than 16-inches.
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15116

PLUG VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Non-lubricated plug valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C517 - Resilient-Seated Cast Iron Eccentric Plug Valves.
   2. C606 - Grooved and Shouldered Joints.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A536 - Standard Specification for Ductile Iron Castings.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals and 15110 - Common Work Results for Valves.

B. Product data.

C. Shop drawings.

D. Calculations.

E. Vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Manuals.

F. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning:
      a. Interior coating.
   2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 15110 - Common Work Results for Valves.

2.02 NON-LUBRICATED PLUG VALVES

A. Manufacturers: One of the following or equal:
   1. DeZurik, "PEC".
   2. Clow / Kennedy Valve.
   3. Val-Matic
   4. Milliken Valve, Model 600/601.

B. Design:
   1. Type: Non-lubricated eccentric type, in accordance with AWWA C517.
   2. Plug face: Resilient material that operates satisfactorily at a temperature of 180 degrees Fahrenheit continuous and 215 degrees Fahrenheit intermittent, except for valves in compressed air or digester gas service.
      a. Valves in compressed air service: Resilient material suitable for continuous duty at 250 degrees Fahrenheit.
      b. Valves in digester gas service: Resilient material suitable for petroleum or digester gas at continuous duty at 180 degrees Fahrenheit.
   3. Compression washer: Provide flat compression washer made of Teflon™, or of a material having equal physical characteristics on valve stem between plug and bonnet.
   4. Stem seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
   5. Grit excluders: Provide PTFE grit excluders at upper and lower plug journals to prevent entry of foreign solids in bearing area.
   6. Clearly mark valves to indicate their open and closed positions.
   7. Provide valves with ends as required by piping details indicated on the Drawings.
      a. Grooved end body valves:
         1) Usage: Plug valves with grooved ends may be used in piping systems specified in the Piping Schedule to have grooved end joints and as indicated on the Drawings.
         2) Grooved end joint design: In accordance with AWWA C606.

C. Materials:
   1. Body and plug: ASTM A126, Class B, cast-iron, with plug face of EPDM material suitable for the intended service as specified under paragraph "Design" above.
   2. Body seats in valves 3 inch size and larger: Provide with overlay of not less than 90-percent nickel and minimum thickness of 1/8-inch on surfaces contacting the plug face.
   3. Stem bearing and bottom bearing: Type 316 stainless steel.
   4. Internal parts, except the body and plug: Type 316 stainless steel.
   5. Exposed nuts, bolts, and washers: Zinc plated. Exception: Exposed nuts, bolts, and washers for buried service: Stainless steel.

2.03 VALVE OPERATORS

A. Furnish valves with an operating wrench or worm gear operator:
   1. Equip valves 4 inch nominal size and smaller with a lever operator.
   2. Equip valves 6 inch nominal size and larger with a worm gear operator.

2.04 COATING

A. Coat and test interior metal surfaces as specified in Section 15110 - Common Work Results for Valves.

B. Field applied coating of valve exterior:
   1. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coatings.
      a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
      b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.05 SHIPMENT, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves as specified in Section 15110 - Common Work Results for Valves and the manufacturer's instructions.
   1. Unless differently indicated on the Drawings install valves so that in the closed position the pressure in the pipeline applies a seating head on the valves.
   2. Install valves so that in the open position the plug is located in the top half of the valve body.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

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SECTION 15117

SPECIALTY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Specialty valves.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 25 - Earthquake-Actuated Automatic Gas Shutoff Devices.

B. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. American Water Works Association (AWWA):
   1. C511 - Standard for Reduced Pressure-Principle Backflow-Prevention Assembly.
   2. C800 - Underground Service Line Valves & Fittings (Also Included: Collected Standards For Service Line Materials).

D. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A536 - Standard Specification for Ductile Iron Castings.
   5. B584 - Standard Specification for Copper Alloy Sand Castings for General Application.

E. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Backflow preventer certification.

2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 BACKFLOW PREVENTERS

A. Manufacturers: One of the following or equal:
   1. Febco backflow prevention:
      a. Model LF860 all sizes.
   2. Zurn/Wilkins:
      a. Model 975XL for 1/2-inch through 2-inch.
      b. Model 375AST for sizes 2 1/2 inch, 3 inch, 8 inch, and 10 inch.
      c. Model 375 and 375DA for sizes 4 inch and 6 inch.
   3. Watts regulator: Series LF909.

B. Design: Reduced pressure chamber type in accordance with AWWA C511.

C. Include shutoff valves at each end of backflow preventer with properly located test cocks.

D. Shutoff valves:
   1. Backflow preventers 2-inch and smaller: Provide with full-port, quarter turn, resilient seated ball valves.
   2. Backflow preventers larger than 2-inch: Provide with resilient seated, outside stem and yoke gate valves.

2.02 SOLENOID VALVES

A. 2-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Co., Series 8210.
         1) Contractor shall provide external bypass to solenoid valve. External bypass shall use pipe of same material and size as main line and include a ball valve for manual operation.
      b. Skinner Electric Valve Division, Series C.

B. 3-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Co., Series 8320.
      b. Skinner Electric Valve Division, Type A4.

C. 4-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Co., Bulletin 8344.
      b. Skinner Electric Valve Division, Series V9.

D. Design:
   1. Valves: Suitable for service under the following conditions:
      a. Fluid water.
      b. Temperature of fluid: 40-80 degrees Fahrenheit.
      c. Piping test pressure: 120 pounds per square inch gauge.
   2. Unless otherwise indicated on the Drawings, provide valves that meet the following requirements:
      a. Minimum NEMA Type 4 enclosure.
      b. 120 VAC operation.
      c. Suitable for use as indicated on the Drawings.
      d. Minimum Class F coil insulation.
   3. 2-way valves: Furnish with openings of size equal to or larger than the nominal size designation of the valve.
   4. Furnish with manual/bypass operators.

E. Materials:
   1. Body: Brass or bronze.
   2. Seats: Resilient material.

2.03 PLASTIC BODY DIAPHRAGM VALVES

A. Type of service: Use plastic body diaphragm valves in the following services:
   1. Polymer solutions.
   2. Neat polymer.

B. Manufacturers: One of the following or equal:
   1. Simtech.
   2. Chemtrol.
   3. Asahi-America.
   4. Georg Fischer Piping Systems.
   5. Hayward Flow Control.

C. Materials:
   1. Body: PVC with reinforcing ribs at body and end connections.
   2. Diaphragm: Unless otherwise specified below, provide 2 diaphragm layers - Teflon™ diaphragm with EPDM backing or other material suitable for the intended use.
      a. For sodium hypochlorite service: 3 diaphragm layers, Teflon™ (PTFE), PVDF, and ethylene propylene diene (EPDM) or Viton™ backing cushion.
   3. Bonnet: PVC with cast iron or silicon bronze drive nut, double lead acme stem threads, acrylic protective cap and visual position indicator.
      a. Adjustable travel stop: Stainless steel.
      b. Compressor: PVDF or cast iron.
   4. Handwheel: Polypropylene.
   5. Sleeve: Bronze or cast iron.
   6. Stem: Stainless steel.
   7. Bolt, nut, and washer: Stainless steel.
   8. Thrust bearing: Teflon™ disc or carbon steel.
   9. End connector: PVC.

10. End connector seal (flange gasket): Suitable for the intended use unless otherwise specified below.
    a. For sodium hypochlorite and sodium bisulfite solution service: Hypalon 1/8-inch thick gaskets.
11. O-rings: Viton™.
12. Position indicator: Carbon steel.

D. Valve design:
1. End connections: Flanged.
2. Operator handle: Handwheel, with position indicator and adjustable travel stop to prevent overtightening. Provide acrylic stem cap.
3. Diaphragm valves: Weir type.
4. Pressure: 150 pound per square inch gauge at 70 degrees Fahrenheit.

E. Electric actuator:
1. Manufacturers: One of the following or equal:
    a. Asahi/America.
    b. Barton/ITT Fluid Technology Corporation.
    c. Gemu.
2. General:
    a. Reversing type motor.
    b. Suitable for 115 volt, 1 phase, 60 hertz power supply.
    c. Travel stop limit switches with remote valve open and closed status indication.
    d. Brushless, capacitor-run motors with integral thermal overload protection and auto reset.
    e. Permanently lubricated gear train.
    f. Visual position indicator.
    g. Declutchable manual override.
3. Materials:
    a. Actuator housing: Aluminum.
    b. Output shaft: Stainless steel.
    c. Electrical housing: NEMA Type 4.
    d. Enclosure: NEMA Type 4.
    e. Thermally bonded epoxy powder coating with stainless steel trim.

2.04 SAMPLING VALVES

A. Manufacturers: The following or Owner/Engineer approved equal:
1. Strahman, Model SV-800.

B. Design Requirements: Sampling valve shall be configured with a 1” MNPT inlet and ¾” FNPT outlet. Seat design shall meet ANSI Class VI, bubble tight shutoff. Sampling valve shall be constructed with a piston configured for linear travel and a multi-turn handle for manual operation. The piston shall completely fill the valve interior allowing for no cavities. The valve will be self-pigging and will not clog. The piston shall have a 1” extension that shall extend beyond the threaded inlet to break through any product crust.

C. Materials:
1. Wetted materials: Type 316 SST.
2. Seat: PTFE.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 - Common Work Results for Valves in accordance with manufacturer's published instructions.

B. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade or top of containment wall.

C. Plastic body diaphragm valves for sodium hypochlorite service:
   1. When valves are installed horizontally, install valves with valve stem position rotated as necessary such that no internal valve obstruction prevents the passage of vapors traveling along the top of adjacent piping from traveling through the valve.

D. Backflow preventers:
   1. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade or top of containment wall.
   2. Install with sufficient side clearance for access for testing and maintenance.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      a. For the following valves:
         1) Flow control valves, backflow preventer, pump control valves, surge preventer valves, metal body diaphragm valves, plastic body diaphragm valves, and earthquake actuated automatic gas shutoff valve.
      b. Installation: 1 trip, 1 day minimum.
      c. Functional Testing: 1 trips, 1 day minimum each.
      d. Training:
         1) Maintenance: 2 hours per session, 2 sessions.
         2) Operations: 2 hours per session, 2 sessions.

C. Functional testing:
   1. Flow control valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.
   2. Backflow preventer:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.
      c. Backflow preventer certification.

3. Pump control valves:
    a. Test witnessing: Witnessed.
    b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.
4. Plastic body diaphragm valves:
    a. Test witnessing: Witnessed.
    b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15118

PRESSURE REDUCING AND PRESSURE RELIEF VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pressure reducing and pressure relief valves for water, air, sludge and chemical service.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

B. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A536 - Standard Specification for Ductile Iron Castings.

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 WATER PRESSURE REDUCING VALVES

A. Water pressure reducing valves, 2 1/2 inches and smaller:
   1. Manufacturers: One of the following or equal:
      a. Watts Regulator, Series LF223.
      b. Wilkins, 500 Series.
   2. Direct operated, single seat type pressure reducing valve.
   3. Materials:
      a. Body and spring cover: Bronze.
      b. Valve seat: Series 300 stainless steel.

c. Diaphragm: Reinforced Buna Nitrile.
d. Disk: EPDM.

B. Water pressure reducing valves, 3 inches and larger:
1. Manufacturers: One of the following, or equal:
a. Watts ACV Series 115.
b. Cla-Val Model 90-01.
2. Design:
a. Pilot controlled, hydraulically operated, diaphragm actuated, globe patterned valve.
b. Rated for 125 pounds per square inch gauge.
c. Pilot line: Equipped with a strainer.
d. Flanges: 150 pound rating, in accordance with ASME B16.42.
3. Materials:
a. Body and cover: Cast iron ASTM A48 or Ductile Iron ASTM A536.
b. Valve trim: Bronze.
c. Pilot control: Cast bronze with Series 303 stainless steel trim.
d. Diaphragm: Nylon reinforced Buna N or Neoprene.

2.02 WATER PRESSURE RELIEF VALVES

A. Water pressure relief valves:
1. Manufacturers: One of the following, or equal:
a. Watts ACV Series 116.
b. Cla-Val Model 50-01.
2. Design:
a. Pilot controlled, hydraulically operated, diaphragm actuated, globe patterned valve.
b. Rated for 125 pounds per square inch gauge.
c. Pilot line: Equipped with a strainer.
d. End connections:
1) 2 1/2 inch and smaller: Screwed.
2) 3 inch and larger: 150 pound rated flanges in accordance with ASME B16.42.
3. Materials:
a. Body and cover: Cast iron ASTM A48 or Ductile Iron ASTM A536.
b. Valve trim: Bronze.
c. Pilot control: Cast bronze with Series 303 stainless steel trim.
d. Diaphragm: Nylon reinforced Buna N or Neoprene.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 - Common Work Results for Valves.

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coatings:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

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SECTION 15119

AIR AND VACUUM RELIEF VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Air release valves, air and vacuum valves, and air vents.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA).

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   3. A270 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing.
   4. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bond.

PART 2 PRODUCTS

2.01 AIR RELEASE VALVES, WATER SERVICE

A. Manufacturers: One of the following or equal:
   1. Valve and Primer Corp., DeZURIK/APCO Series 200.
   2. Multiplex Manufacturing Co., Crispin PL Series.
   3. ARI Flow Control.

B. Design:
   1. Pressure rating: 150 pounds per square inch gauge**.**
   2. Inlet: Screwed, 2-inch.
   3. Orifice size: 1/4-inch diameter.

C. Materials:
   1. Valve body: Cast iron.
   2. Float and internal trim: Type 316 stainless steel.
   3. Seat or valve plunger: Buna-N.

2.02 AIR AND VACUUM VALVES, WATER SERVICE

A. Manufacturers: One of the following or equal:
   1. Valve and Primer Corp., DeZURIK/APCO Series 140.
   2. Multiplex Manufacturing Co., Crispin A Series.
   3. ARI Flow Control, D-021.

B. Design:
   1. Minimum performance requirements:
      a. Air in-flow through valve: Not less than 2.0 standard cubic feet per second.
      b. Air exhaust through valve: Not less than 0.67 standard cubic feet per second.
   2. Pressure rating: Suitable for service under operating pressures equal to and less than 125 pounds per square inch gauge.
   3. Inlet: Screwed, 2-inch in size and smaller. For all other valves sizes, use flanged inlet.

C. Materials:
   1. Body: Cast iron.
   2. Float: Type 316 stainless steel.

2.03 COMBINATION AIR VALVES, WATER SERVICE

A. Manufacturers: One of the following or equal:
   1. Valve and Primer Corp., DeZURIK/APCO, Series 140C.
   2. Multiplex Manufacturing Co., Crispin UL Series.
   3. ARI Flow Control.

B. Design:
   1. Operation: Automatic exhaust of large quantities of air from pipelines during filling and draining and release of accumulated air while pipeline is under pressure.
   2. Utilize compound lever system in conjunction with large and small orifices.

3. Internal parts removable through top cover without removing valve from pipeline.
4. Pressure rating: 125 pounds per square inch.
5. Inlet: Screwed, 2 inch size.

C. Materials:
1. Body: Cast iron.
2. Float: Type 316 stainless steel.
3. Needle: Buna-N.
4. Lever frame: Cast iron or Delrin.

2.04 AIR RELEASE VALVES, SEWAGE SERVICE

A. Manufacturers: One of the following or equal:
1. Valve and Primer Corp., DeZURIK/APCO, Series 400.
2. Multiplex Manufacturing Co., Crispin Series S.
3. ARI Flow Control.

B. Design:
1. Operation: Release accumulated air in sewage pipelines operating under pressure. After entrained air escapes through the orifice, the orifice is plugged by a needle mounted on a compound lever mechanism.
2. Internal components removable through top cover without removing valve from pipeline.
3. Pressure rating: 150 pounds per square inch.
4. Orifice size: 1/4-inch diameter.
5. Connections: Threaded, 2-inch diameter inlet and threaded, 1/2-inch diameter outlet.

C. Accessories:
1. Inlet shutoff valve. Utilize eccentric plug valve.
2. 2 blowoff valves for backflushing.
3. 10 feet of hose with quick disconnect couplings.

D. Materials:
1. Body: Cast iron.
2. Float: Type 316 stainless steel.
3. Needle: Buna-N.

2.05 AIR AND VACUUM VALVES, SEWAGE SERVICE

A. Select type of sewage-service air and vacuum release valve from the 2 options provided. Furnish only 1 style of air and vacuum release valve for the entire project.
1. Option 1: Float activated air and vacuum release valve.
2. Option 2: Anti-surge type air and vacuum release valve.

B. Option 1: Float activated air and vacuum release valves:
1. Manufacturers: One of the following or equal:
a. Multiplex Manufacturing Co., Crispin SA Series.
b. Valve and Primer Corp., DeZURIK/APCO, Series 401.
c. ARI Flow Control: D-025.
d. G-A Industries, Inc., Figure 942.

2. Design:
    a. Operation: Release air from pipeline as pipeline is filled and allow air to enter pipeline as pipeline is drained.
    b. Internal components removable through top cover without removing valve from pipeline.
    c. Pressure rating: 150 pounds per square inch.
3. Accessories:
    a. Inlet shutoff valve. Utilize eccentric plug valve.
    b. 2 blowoff valves for backflushing.
    c. 10 feet of hose with quick disconnect couplings.
4. Connections: 2-inch threaded inlet and 1-inch threaded outlet.
5. Materials:
    a. Body: Cast iron.
    b. Float: Type 316 stainless steel.
    c. Seat: Buna-N.

C. Option 2: Anti-surge type air and vacuum release valve.
1. Manufacturers: The following or equal:
    a. RF Valve, Vent-O-Mat, series RGX.
2. Design:
    a. Operation: Release air from pipeline as pipeline is filled and allow air to enter pipeline as pipeline is drained. Design valve to react immediately to break vacuum upon pipeline drainage or liquid column separation by the full opening of the orifice.
    b. Design: Consisting of a tubular chamber with a hollow, direct acting float, solid cylindrical orifice control float, woven dirt inhibitor screen, and rubber seats.
    c. Surge alleviation: Integral surge alleviation mechanism that operates automatically to limit transient pressure rise or shock. Induce operation of anti-surge mechanism by closure due to high velocity air discharge or the subsequent rejoining of separated liquid columns.
    d. Control discharge of pressurized air by the seating and unseating of a small orifice on a seal affixed to the control float. Provide a nozzle with a flat seating land surrounding the orifice to prevent damage to the seal.
    e. Internal components removable through top cover without removing valve from pipeline.
3. Connections: Flanged connections conforming to ASME B16.1 Class 250 and ASME B16.5 Class 300 standards.
4. Performance: Leaktight past the orifice seal at operating pressures to 200 pounds per square inch gauge.
5. Materials:
    a. Body: Type 316 stainless steel.
    b. Float: HDPE.
    c. Seats: EPDM.

2.06 COMBINATION AIR VALVES - SEWAGE SERVICE

A. Manufacturers: One of the following or equal:
1. Valve and Primer Corp., DeZURIK/APCO, Series 440.
2. Multiplex Manufacturing Co., Crispin Series US.
3. ARI Flow Control.

B. Design:
   1. Operation: Automatic exhaust and intake of large quantities of air during filling and draining of pipelines, respectively, and release of accumulated air while pipeline is under pressure.
   2. Design: Utilize compound lever system in conjunction with large and small orifices.
   3. Internal parts removable through top cover without removing valve from pipeline.
   4. Pressure rating: 150 pounds per square inch.
   5. Connections: 2-inch threaded inlet and 1-inch threaded outlet.
   6. Accessories:
      a. Inlet shutoff valve.
      b. 2 blowoff valves for backflushing.
      c. 10 feet of hose with quick disconnect couplings.

C. Materials:
   1. Body: Cast iron.
   2. Float: Type 316 stainless steel.
   3. Needle: Buna-N.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 - Common Work Results for Valves and manufacturer's instructions.

B. Install air release valves and air and vacuum valves with suitable discharge lines to nearest drainage system.

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coatings.
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, remove existing coating by abrasive blast cleaning and apply the coating system used for coating adjacent piping in accordance with Section 09960 - High-Performance Coatings.
      a. Submerged valves: SP-5 White Metal Blast cleaning.
      b. Other valves: SP-10 Near-white blast cleaning.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Piping specialties including:
   1. Flexible rubber connections.
   2. Bellows type expansion joints.
   3. Rubber expansion joints.
   4. Pipe saddles.
   5. Tapping sleeves.
   6. Spray nozzles.
   7. Washdown monitors.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. A148 - Standard Specification for Steel Castings, High-Strength, for Structural Purposes.
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 – Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   4. A536 - Standard Specification for Ductile Iron Castings.

D. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects, Includes Errata.
   2. 372 - Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data:
   1. For each piping product in this Section as applicable:
      a. Design features.
      b. Load capacities.
      c. Material designations by UNS alloy number or ASTM Specification and Grade.
      d. Data needed to verify compliance with the Specifications.

e. Catalog data.
f. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

C. Calculations:
1. Provide calculations in accordance with NSF 372 for materials in contact with drinking water.

D. Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning:
1. Provide as specified in this Section.

1.04 WARRANTY

A. Provide 1 year warranty covering workmanship and materials. Warranty shall commence at the time of substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

B. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.

2.02 FLEXIBLE RUBBER CONNECTIONS

A. Manufacturers: One of the following or equal:
1. Mercer Rubber Co., Type 150 Vibraflex.
2. Red Valve Co., Inc., Part Number P-5.

B. Provide flexible rubber connections with 3/8 inch thick neoprene rubber tube with full-faced flanged ends suitable to withstand a pressure of 150 pounds per square inch gauge.

C. Provide complete flexible rubber connections, including galvanized retaining rings and control rods.

2.03 BELLOWS TYPE EXPANSION JOINTS

A. Expansion joints for general service:
1. Expansion joints: Flexible bellows type, or as otherwise specified or indicated on the Drawings.
2. Manufacturers:
a. Expansion joints: One of the following or equal:
1) Senior Flexonics Pathway, Inc., Controlled Flexing Expansion Joint.
2) Flex-Weld, Inc., Keflex, Series 308.
3) Victaulic, Depend-o-Lok, Omniflex stainless bellows expansion joint.
b. Pipe alignment guides: One of the following or equal:
1) Senior Flexonics Pathway, Inc.
2) Flex-Weld, Inc.

c. Intermediate supports: Provide with protective saddles. One of the following or equal:
1) Unistrut Corporation, Roller-type.
2) Bergen-Paterson Pipe Support Corp.

3. Design:
a. Expansion joint rating: 150 pounds per square inch gauge, at 300 degrees Fahrenheit.
b. Bellows: Multi-ply (3 ply minimum) stainless steel, equipped with a self-draining liner guide.
c. Axial travel of expansion joints: Not less than 1.50 inches.
d. Ends: 150 pound ASME flanges, Victaulic, Depend-o-Lok Airmaster/Fluidmaster coupled ends, or plain suitable for welding connections, as required for piping in which installed.

B. Expansion joints for steam and hot water:
1. Manufacturers: One of the following or equal:
a. Flex-Weld, Inc., Keflex, Series 308-1215.
b. Senior Flexonics Pathway, Inc., Controlled Flexing Expansion Joint.
c. Victaulic, Depend-o-Lok Omniflex Expansion Join.
2. Design:
a. Single reinforced bellows type or Victaulic mechanical couplings.
b. Pressure and temperature ratings: 150 pounds per square inch gauge, and 500 degrees Fahrenheit service.
c. Bellows: Multi-ply (3 ply minimum) Type 321 stainless steel, equipped with a Type 321 stainless steel liner.
d. Axial travel of expansion joints: 3 inches minimum.
e. Ends: 150 pound ASME flanges.

C. Copper piping expansion joints:
1. Expansion joints for copper pipe: As specified before, except externally guided, and provide for 3-1/4 inch expansion per 100 feet of piping.

D. Roof drain expansion joints:
1. Neoprene bellows between roof drain fitting and drain piping.
2. Up to 12-inch static head.
3. Complete with Type 316 stainless steel clamps.
4. Manufacturers: One of the following or equal:
a. Watts, Model RD-900.
b. Flexicraft Industries, DWV.

2.04 RUBBER EXPANSION JOINTS FOR AIR AND WATER

A. Manufacturers: One of the following or equal:
1. Proco Products, Inc., Series 230 or 240.
2. Mercer Rubber Co., Style 500 or 700.
3. Red Valve Co., Inc., Type J-1.

B. Provide rubber expansion joints complete with control units and split retaining rings.

C. Design:
1. Material: Neoprene rubber, reinforced with embedded steel rings, and a strong synthetic fabric.

2. Expansion rings, suitable for pressures of at least 125 pounds per square inch gauge, except as follows:
    a. Expansion joints in pump suction piping and where indicated on the Drawings suitable for minimum 90 pounds per square inch gauge pressure, and minimum 30 inches mercury vacuum.
    b. Ends of expansion joints, 150 pound ASME flanges with drilling to match that of the piping.
3. Bolts, nuts, control rods/plates, and retaining rings shall be galvanized steel unless otherwise specified.
4. Bolts, nuts, control rods/plates, and retaining rings for low pressure air systems provide materials matching the piping system.
5. Bolts, nuts, control rods/plates, and retaining rings submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.

D. Rubber expansion joints for low pressure air: Butyl type rubber formulated for service application and for maximum temperature of 250 degrees Fahrenheit, suitable for minimum 40 pounds per square inch gauge pressure, and minimum 15 inches mercury vacuum.
1. Expansion joint shall provide minimum 1.6-inch axial compression and 0.8-inch axial extension.
2. Expansion joint shall provide minimum 0.8-inch lateral deflection for pipe diameters 12 to 16 inches.
3. Unless otherwise noted, all joints on low pressure air piping shall be this type.

2.05 PIPE SADDLES

A. For ductile iron pipe:
1. Double strap brass type.
2. Manufacturers: One of the following or equal:
    a. A.Y. McDonald, Style 3825
    b. The Ford Meter Box Company, Style 202B
    c. Mueller Company, Style BR2B.
3. Materials:
    a. Pipe saddle body, straps, and nuts: Brass or silicon bronze.
    b. Gaskets: EPDM.

B. For PVC C900 or C905 pipe:
1. Manufacturers: One of the following or equal:
    a. Smith-Blair, Inc., Style 317.
    b. Romac Industries, Inc., Style 202S.
2. Materials:
    a. Pipe saddles: Ductile iron with fusion bonded epoxy finish.
    b. Straps, bolts, and nuts: Type 304 stainless steel with Teflon™ coating on nuts.
    c. Gaskets: EPDM.

2.06 TAPPING SLEEVES

A. Manufacturers: One of the following or equal:
   1. Smith-Blair, Inc., Style 622.
   2. Romac Industries, Inc., Style FTS 420.

B. Materials:
   1. Tapping sleeves: Steel construction.
   2. Bolts and nuts: Type 304 stainless steel.
   3. Nuts: Teflon™ coated.
   4. Gaskets: EPDM.
   5. Size of tapped boss: As indicated on the Drawings.

2.07 SPRAY NOZZLES

A. Design:
   1. Operating pressure 10 pounds per square inch gauge, at which pressure each nozzle discharges not less than 3.5 gallons per minute, nor more than 5.0 gallons per minute.
      a. Spray: Flat, heavy sheet, fan with uniform distribution.
      b. Fan width at the water surface not less than 6.5 feet at 10 pounds per square inch gauge.
      c. Spray deflection with a replaceable deflector insert free to rotate away from the orifice opening and mechanically locked in place and counterweighted.
   2. Spray nozzles structurally suitable for pressure up to 200 pounds per square inch gauge.
   3. Nozzles, easy flush type.

B. Materials:
   1. Spray nozzles: Leaded bronze.
   2. Nozzles provided with 1/4 inch national pipe thread, and the orifice diameter not less than 1/4 inch.
   3. Replaceable spray deflector: Neoprene rubber.

2.08 PORTABLE WASHDOWN MONITORS

A. Monitor:
   1. Provide one portable washdown monitor per pair of aeration basins.
   2. Design for a minimum water stream reach of 120 feet when operated at a design rating of 150 gallons per minute at 80 pounds per square inch line pressure.
   3. The horizontal rotation shall be minimum 90 degrees, the vertical swivel shall be 90 degrees.
   4. 1-1/2-inch discharge.
   5. Fabricated from Schedule 40 heavy wall seamless pipe. Pressure tested to a minimum 300 pounds per square inch for 5 minutes.
   6. Horizontal and vertical motion shall be accomplished by a single tiller bar handle with PVC grip.
   7. Horizontal and vertical joints shall be capable of being locked at any position.
   8. Swivel joints shall be double sealed and contain 2 rows of Type 304 stainless steel ball bearings.
      a. The seal shall be Buna-N cup steel type.

b. Provisions shall be made for external lubrication of the swivels through zerk fittings.
9. Radial forces shall be completely balanced through a single sweeping water way. No division and remating of the waterway shall be allowed.
10. Monitor shall be mounted on wheeled dolly or collapsible for easy transport.
11. The finish shall be fusion bonded dry powder epoxy for interior and exterior;
12. Manufacturers: The following or equal:
a. Fusecoat.

B. Nozzle:
1. Straight stream tapered nozzle.
2. Molded from rigid Polyurethane.
3. Designed for a burst pressure of 800 pounds per square inch.
4. Inlet: 1-1/2 inch threaded NH metal insert.
5. Outlet: Stainless steel orifice insert available in various diametrical increments.
6. The nozzle shall incorporate straightening vanes to prevent breakup of the water stream within the reach required.

C. Manufacturers: One of the following or equal:
1. Stang Industries, Inc., Porta-Snorkel.
2. Potter Roemer, FPPM-125
3. Akron Brass, equivalent model.

2.09 SHIPPING

A. As specified in Section 01600 - Product Requirements.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

B. Drawings supersede conflicts with this Section.

C. Bellows type expansion joints and vibration control joints:
1. Protect joints against damage during pressure test.

3.02 INSTALLATION

A. Expansion control joints:
1. Install bellows type expansion control joints at piping connections to mechanical equipment to prevent damaging stresses due to normal expansion and contraction with temperature changes in piping and connected equipment.
2. Install bellows type expansion joints so as to allow 2-1/4 inch expansion per 100 linear feet of piping.
3. Install expansion joints adjacent to an anchor, and provide 1 concentric guide on piping within 12 pipe diameters, but not more than 5 feet, from the end of the joint opposite the anchor.
a. Locate a similar guide approximately 30 diameters but not more than 10 feet from the first.

4. For expansion joints not installed adjacent to an anchor provide 2 concentric guides similarly located at each end of the joint.
5. Provide control rods and additional guides where indicated on the Drawings, but at no greater intervals than recommended by the joint manufacturer in published instructions.
6. Space intermediate supports a minimum of 10 feet, and tack weld the protective saddles to the pipe.

B. Bellows type expansion joints for steam and hot water:
1. Install not less than 1 expansion joint in a run of steam or hot water piping which exceeds 20 feet in length.
a. Do not exceed 150 feet spacing of expansion for steam piping and 200 feet for hot water piping.
2. Where possible, install expansion joints adjacent to an anchor; provide piping with 2 concentric guides, the first being within 2 feet of the end of the joint opposite the anchor.
3. At expansion joints not installed adjacent to an anchor, provide 2 concentric guides on piping within 2 feet off both ends of the expansion joint.
4. Lock expansion joint against movement until pressure test is completed.

C. Transition couplings:
1. Application:
a. Use transition couplings with function and design similar to flexible couplings and flanged coupling adapters for connecting piping having different outside diameters.
2. Install transition-coupling products specifically designed and manufactured for that application.

D. Pipe saddles:
1. Coat threads on bolts with anti-gall coating prior to installation.

E. Tapping sleeves:
1. Verify existing pipe material and outer diameter prior to ordering materials.
2. Large diameter pipe:
a. Verify the existence of lining material.
b. Verify lining material type.
c. Repair lining after hot tap operations are complete with similar lining or equal.
d. Demonstrate ability to accomplish hot tap by staging a dry run simulation of the procedure prior to the initiation of the hot tap procedure.
1) Walk through each step of the hot tap installation, and show the Engineer every component needed to install the hot tap, including but not limited to, tools and materials, to ensure that all the required components are on-site and in place prior to beginning the procedure.
3. Coat threads on bolts with anti-gall coating prior to installation.

F. Spray nozzles:
1. Install spray nozzles so that elevation of the nozzles is 18 inches above the water surface.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Required only for:
      a. Transition couplings.
      b. Tapping sleeves for large diameter pipe.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.
   3. Provide Manufacturer's Representative Onsite:
      a. Installation: 2 trip/1 day each:
         1) Installation consultation and advice.
         2) Installation inspection.

C. Field testing:
   1. As specified in Section 15052 - Common Work Results for General Piping.
   2. Protect bellows type expansion joints and vibration control joints.

END OF SECTION

SECTION 15121

PIPE COUPLINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pipe couplings for ductile iron piping.
   2. Pipe couplings for stainless steel piping.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.9 - Building Services Piping.

C. American Water Works Association (AWWA):
   1. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   2. C207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.
   3. C606 - Standard for Grooved and Shouldered Joints.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   6. A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/9 ksi Minimum Tensile Strength, General Use.
   7. A536 - Standard Specification for Ductile Iron Castings.
   8. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   9. A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   10. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
   11. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

12. F594 - Standard Specification for Stainless Steel Nuts.
13. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.
2. 372 - Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
1. For each product in this Section as applicable:
a. Design features.
b. Load capacities.
c. Material designations by UNS alloy number or ASTM Specification and Grade.
d. Data needed to verify compliance with the Specifications.
e. Catalog data.
f. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

C. Calculations:
1. Provide calculations in accordance with NSF 372 for materials in contact with drinking water.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements:
1. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.

B. Known acceptable manufacturers are listed by specific products.

C. Provide references as specified in this Section by specific product.

D. Manufacturer’s representative’s requirements as specified in Section 01756 - Commissioning and this Section by specific product.

E. Gaskets for flexible couplings and flanged coupling adapters:
1. Provide gasket materials for piping applications as follows:
a. Low-pressure and high-pressure air, steam, hot water: EPDM.
b. All other piping applications: Neoprene rubber or Buna-N.

F. Exterior coatings for underground and submerged applications:
   1. Manufacturers: One of the following or equal:
      a. Tapecoat Co., Inc., T.C. Mastic.
      b. Kop-Coat Co., Inc., Bitumastic Number 50.
   2. Thickness: Minimum 0.040 inch.

2.02 PIPE COUPLINGS FOR DUCTILE IRON PIPING

A. Dismantling joints:
   1. Manufacturers: One of the following or equal:
      a. Romac Ind., Inc., Style DJ400.
      b. Smith-Blair, Inc., Series 975.
   2. Materials:
      a. Flanged spool: AWWA C207 steel pipe:
         1) ASTM A53 for sizes 3 inches to 12 inches.
         2) ASTM A36 for sizes 14 inches to 72 inches.
      b. End ring and body:
         1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A536.
         2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A36 or A53.
      c. Follower ring: Ductile iron in accordance with ASTM A536.
      d. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
      e. Tie rods: High tensile steel in accordance with ASTM A193 Grade B7.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

B. Flanged coupling adapters: 12-inch size and smaller:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 227.
      b. Romac Ind., Inc., Style FCA501.
      c. Smith-Blair, Inc., Series 912.
   2. Materials:
      a. Flanged body: Ductile iron in accordance with ASTM A536.
      b. Follower ring: Ductile iron in accordance with ASTM A536.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

C. Flanged coupling adapters: Greater than 12-inch size:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 128-W.
      b. Romac Ind., Inc., Style FC400.
      c. Smith-Blair, Inc., Series 913.
   2. Materials:
      a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

D. Flexible couplings:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 253.
      b. Romac Ind., Inc., Style 501.
      c. Smith-Blair, Inc., Series 441.
   2. Materials:
      a. Center rings: Ductile iron in accordance with ASTM A536.
      b. Follower rings: Ductile iron in accordance with ASTM A536.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel in accordance with ASTM F593.
   3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
   4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

E. Restrained flange coupling adapter:
   1. Manufacturers: One of the following or equal:
      a. Romac Ind., Inc., Style RFCA.
      b. Star Pipe Products, 3200 StarFlange™.
   2. Materials:
      a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
      b. Follower ring: Lug type restraint system.
         1) Follower ring: Ductile iron in accordance with ASTM A536.
         2) Restraining lugs: Ductile iron in accordance with ASTM A536.
            a) Designed to contact the pipe and apply forces evenly.
         3) Restraining bolts:
            a) Ductile iron in accordance with ASTM A536.
            b) Bolt heads shall be designed to twist off when the proper torque has been applied.

c. Bolts and hex nuts:
1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
5. Angular deflection: Restrained flange coupling adapter must allow angular deflection after assembly.

F. Grooved joint couplings:
1. Manufacturers: The following or equal:
a. Victaulic Co., Series 31 or equal.
2. Materials:
a. Housings: Ductile iron in accordance with ASTM A536.
b. Gasket:
1) FlushSeal® type, or equal. Elastomer in accordance with ASTM D2000.
2) EPDM.
c. Bolts and nuts: Electroplated steel in accordance with ASTM A449.
d. Coating: As specified in Section 09960 - High-Performance Coatings.
3. For use with rigid or flexible radius grooved components in accordance with AWWA C606.
4. For connection to IPS steel pipe sizes, Victaulic Style 307.

2.03 PIPE COUPLINGS FOR CARBON STEEL PIPING

A. Dismantling joints:
1. Manufacturers: One of the following or equal:
a. Romac Ind., Inc., Style DJ400.
b. Smith-Blair, Inc., Series 975.
2. Materials:
a. Flanged spool:
1) C207 Schedule 40 pipe in accordance with ASTM A53 for sizes 3 inches to 12 inches.
2) Steel for pipe in accordance with ASTM A36 or A53 for sizes 14 inches to 72 inches.
b. End ring and body:
1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A536.
2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A36.
c. Follower ring: Ductile iron in accordance with ASTM A536 or steel in accordance with ASTM A36 or A576.
d. Bolts and hex nuts:
1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
e. Tie rods: High tensile steel in accordance with ASTM A193 grade B7.

3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Fusion bonded epoxy certified in accordance with NSF 61.

B. Flanged coupling adapters:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 128-W.
      b. Romac Ind., Inc., Style FCA501 (10 inch and smaller) or Style FC400 (12 inch and larger).
      c. Smith-Blair, Inc., Series 913.
   2. Materials:
      a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      c. Bolts and hex nuts:
         1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

C. Flexible couplings:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 38.
      b. Smith-Blair, Inc., Series 411.
      c. Romac Ind., Inc., Style 511 or Style 400.
   2. Materials:
      a. Center sleeve and follower flanges: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
   4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

D. Restrained flange coupling adapters:
   1. Manufacturers: One of the following or equal:
      a. Romac Ind., Inc., Style RFCA.
      b. Star Pipe Products, 3200 StarFlange™.
   2. Materials:
      a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
      b. Follower ring: Lug type restraint system.
         1) Follower ring: Ductile iron in accordance with ASTM A536.

2) Restraining lugs: Ductile iron in accordance with ASTM A536.
a) Designed to contact the pipe an apply forces evenly.
3) Restraining bolts: Ductile iron in accordance with ASTM A536. Bolt heads shall be designed to twist off when the proper torque has been applied.

c. Bolts and hex nuts:
1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.

3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy certified in accordance with NSF 61.

E. Grooved joint couplings:
1. Model numbers from one manufacturer are shown to indicate type only. Equivalent products of other manufacturers may be submitted for approval.
2. Coating: As specified in Section 09960 - High-Performance Coatings.
3. Sizes through 12 inch:
a. Rigid type:
1) Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.
2) 2 inch through 6 inch: Installation-ready, for direct stab installation without field disassembly, with grade EHP gasket rated to plus 250 degrees Fahrenheit.
3) Manufacturers: One of the following or equal:
a) Victaulic Style 107.
b) Victaulic Zero-Flex Style 07.

b. Flexible type:
1) For use in locations where vibration attenuation and stress relief are required.
2) Three flexible couplings may be used in lieu of a flexible connector.
3) The couplings shall be placed in close proximity to the source of the vibration.
4) Manufacturers: The following or equal:
a) Victaulic Style 77.

c. Flange adapter:
1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
2) Manufacturers: The following or equal:
a) Victaulic Style 741.

4. Sizes 14 inch through 24 inch:
a. Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.
b. Rigid type:
1) Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.

2) Manufacturers: The following or equal:
a) Victaulic Style W07.

c. Flexible type:
1) Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement.
2) Manufacturers: The following or equal:
a) Victaulic Style W77.

d. Flange adapter:
1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
2) Manufacturers: The following or equal:
a) Victaulic Style W741.

5. For sizes 30 inch and larger:
a. Manufacturers: The following or equal:
1) Victaulic Style AGS multiple-segment housing may be used.

2.04 PIPE COUPLINGS FOR STAINLESS STEEL PIPING

A. Refer to rubber expansion joints in Section 15120 for couplings on low pressure air piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. In underground and underwater installations, coat the exterior of coupling with a protective coating in accordance with manufacturer's instructions.

B. Joints and flexible connections shall be installed centered with no angular deflection unless otherwise indicated on the Drawings.

C. Flexible couplings and flange coupling adapters: Install with gap between pipe ends in accordance with the following table unless a greater gap is indicated on the Drawings. Maximum gap tolerance shall be within 1/8 inch.
1. Install flexible coupling with pipe gap located in middle of center sleeve.
2. Install flanged coupling adapter with end of plain end pipe in middle of flanged coupling body.

D. Provide harnesses (tie-downs) for flexible couplings unless otherwise indicated on the Drawings with a written note.
1. Design harnesses (tie-downs) for the test pressures as specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.

E. Grooved joint couplings:
1. Grooved ends: Clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
2. Gaskets: Elastomer grade suitable for the intended service, and molded and produced by the coupling manufacturer.

F. Bolted, split-sleeve couplings:
   1. Inspect each coupling to ensure that there are no damaged portions of the coupling.
      a. Pay particular attention to the sealing pad/sealing plate area.
      b. Before installation, thoroughly clean each coupling of any foreign substance which may have collected thereon and shall be kept clean at all time.
   2. Wrenches:
      a. Conform to manufacturer instructions.
      b. Bolts and studs shall be tightened so as to secure a uniform gasket compression between the coupling and the body of the pipe with all bolts or studs tightened approximately the same amount.
      c. Final tightening shall be done by hand (no air impact wrenches) and is complete when the coupling is in uniform contact with the outside surface of the pipe all around the circumference of the pipe.
   3. No joint shall be misfit in any plane.
   4. On the fixed ends of bolted, split-sleeve couplings, the shoulders shall bear on the restraint rings all around with no visible gap.
   5. Ends of piping where coupler are installed shall be smooth and free of defects.
      a. Remove weld splatter and grind smooth.
      b. Grind pipe seam welds flush with pipe wall and smooth.

END OF SECTION

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SECTION 15244

POLYVINYL CHLORIDE (PVC) PIPE: AWWA C900

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. AWWA C900 PVC pipe and fittings.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   2. C605 - Standard for Underground Installation of PVC and PVCO Pressure Pipe and Fittings for Water.
   3. C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches to 12 Inches, for Water Transmission Distribution.
   4. M23 – PVC Pipe – Design and Installation Manual.

B. ASTM International (ASTM):
   1. A536 - Standard Specification for Ductile Iron Castings.
   2. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   3. D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
   4. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   5. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 ABBREVIATIONS

A. DR: Dimension ratio.

B. NPS: Nominal pipe size followed by the size designation.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Shop Drawings:
   1. Describe materials, pipe, fittings, and gaskets.
   2. Manufacturer’s product handling and installation instructions.

C. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning - Commissioning.
   1. Include date of manufacture for each lot delivered.

D. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 QUALITY ASSURANCE

A. Pipe in potable water applications: Provide pipe bearing NSF 61 seal.

B. Mark plastic pipe with date of extrusion, nominal size, class, manufacturer and all markings required in accordance with ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect from sunlight, scoring, and distortion.

B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.

C. Deliver, offload, handle, and store pipe in accordance with manufacturer's or pipe supplier's recommendations and best practices provided by AWWA M23 and AWWA C605, including compliance with minimum recommended bending radius and maximum safe pulling forces for each specific pipe.

PART 2 PRODUCTS

2.01 PIPE

A. General:
   1. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.
   2. In accordance with AWWA C900.
   3. Made from a PVC compound conforming to cell classification 12454 in accordance with ASTM D1784.

B. Pipe:
   1. Bell and spigot:
      a. Pipe with integral bell.
      b. Pressure Class as scheduled in Section 15052 - Common Work Results for General Piping.
      c. Manufacturers:
         1) Diamond Plastics Corporation.
         2) CertainTeed.
         3) North American Pipe Corporation.

2.02 FITTINGS

A. Material:
   1. Cast or ductile iron fittings as specified in Section 15211 - Ductile Iron Pipe: AWWA C151, sized for the dimensions of the pipe being used.

B. Equal to or greater pressure rating than the pipe.

2.03 JOINTS

A. Bell and spigot joints:
   1. Push-on or mechanical joint type as identified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.
   2. Gasketed joint assembly: Meet or exceed the requirements in accordance with ASTM D3139.
   3. Factory installed gaskets: Neoprene in accordance with ASTM F477.
   4. Joint restraint at fittings:
      a. Concrete thrust blocks:
         1) Install thrust blocks at all changes in pipe diameter and at all fittings.
         2) Design thrust blocks for both test and peak operating pressures.
      b. Mechanical wedge action joint restraints:
         1) Manufacturers: One of the following or approved equal:
            a) EBAA Iron, Inc.:
               (1) For pipes 3 to 36-inch: Series 2000PV.
               (2) For pipes 42 and 48-inch: Series 2200.
            b) Star Pipe Products, Series 4000.
         2) Materials:
            a) Gland body: Ductile iron in accordance with ASTM A536.
            b) Wedge and wedge actuating components: Ductile iron in accordance with ASTM A536.
               (1) Wedges: Heat-treated to a minimum of 370 BHN.
            c) Actuating bolts and nuts: Ductile iron in accordance with ASTM A536.
               (1) Provide torque-limiting twist off components to ensure proper installation.
         3) Coatings:
            a) Provide a manufacturer applied coating system.
            b) Manufacturers: One of the following or equal:
               (1) EBAA Iron Inc., Mega-Bond.
               (2) Star Pipe Products, Star-Bond.
         4) Consist of multiple gripping wedges incorporated into a follower gland meeting the requirements in accordance with AWWA C111.
         5) Allow post assembly angular deflection that is a minimum of 50 percent of the angular deflection allowed by the mechanical joint.
         6) Pressure rating equal to or greater than that of the pipe on which it is being used and a minimum safety factor of 2:1 for all sizes.
      c. Push-on joint restraint harnesses:
         1) Manufacturers: One of the following or approved equal:
            a) EBAA Iron, Inc.:
               (1) For pipes 4 to 12-inch: Series 1500.
               (2) For pipes 14 to 48-inch: Series 2800.
            b) Star Pipe Products, Series 4100P.

2) Materials:
   a) Restraint and backup rings: Ductile iron in accordance with ASTM A536.
   b) Wedge and wedge actuating components: Ductile iron in accordance with ASTM A536.
   c) Tie rods: Low alloy steel in accordance with AWWA C111.
3) Coatings:
   a) Provide manufacturer applied coating system.
   b) Manufacturers: One of the following or equal:
      (1) EBAA Iron Inc., Mega-Bond.
      (2) Star Pipe Products, Star-Bond.
4) Consist of a backup ring behind the PVC bell and a restraint ring consisting of multiple gripping wedges connected with number and type of tie rods as recommended by the manufacturer.
5) Allow post assembly angular deflection that is a minimum of 50 percent of the angular deflection allowed by the push-on joint.
6) Pressure rating equal to or greater than that of the pipe on which it is being used and a minimum safety factor of 2:1 for all sizes.

2.04 SOURCE QUALITY CONTROL

A. Bell and spigot piping:
   1. Hydrostatic proof testing in accordance with AWWA C900: Test pipe and integral bell to withstand, without failure, 2 times the pressure class of the pipe for a minimum of 5 seconds.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Install piping in accordance with ASTM F645, AWWA C605, the Appendix of AWWA C900 and manufacturer's or pipe supplier’s published installation instructions.
   2. For open cut installations, install underground warning tape as specified in Section 15076 - Piping Identification.
   3. Install pipe with tracer wire as specified in Section 15076 - Piping Identification.

B. Tapping:
   1. Direct tapping:
      a. Direct taps are allowed for AWWA C900 Class 235 and Class 305 pipe, NPS 6-inch through 12-inch only.
      b. 1-inch is the maximum allowable outlet size for performing a direct tap.
   2. Saddle tapping:
      a. Saddle taps are allowable on all sizes and classes of AWWA C900 pipe.
      b. 2-inch is the maximum allowable outlet size for performing a saddle tap.
      c. As specified in Section 15120 - Piping Specialties for allowable service saddles.

3. Tapping sleeves:
    a. Tapping sleeves are allowable on all sizes and classes of PVC AWWA C900.
    b. As specified in Section 15120 - Piping Specialties for allowable tapping sleeves.

3.02 FIELD QUALITY CONTROL

A. Leakage test for piping:

1. Subject to visible leak test and pressure test with maximum leakage allowance, as specified in Section 15956 - Piping Systems Testing.
2. Pressure test with maximum leakage allowance.
    a. Perform test after placing sufficient backfill.
    b. In areas requiring immediate backfill, test prior to placement of permanent surfacing.
    c. Test pressure: As specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.
    d. Maximum leakage allowance for bell and spigot pipe is as follows, where the value for leakage is in gallons per 50 joints per hour.

Test Pressure (psi)	Nominal Pipe Size (inches)									
	4	6	8	10	12	14	16	18	20	24
50	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15
75	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62
125	0.3	0.45	0.6	0.76	0.91	1.06	1.21	1.36	1.51	1.81
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99
175	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15
200	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29
225	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43
250	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56
275	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69
300	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81

    e. No leakage is allowed for FPVCP.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
Source Testing (Witnessed or Non-witnessed)	**Training Requirements**		**Installation Testing**		**Functional Testing**		**Process Operational Period**	
	Maintenance (hrs per session)	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-witnessed	Not required		Not required		Not required		Not required	

END OF SECTION

SECTION 15259

CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE: ASTM F441

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: ASTM F441 CPVC pipe and fittings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   2. F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
   3. F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
   4. F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
   5. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
   6. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.

1.03 ABBREVIATIONS

A. CPVC: Chlorinated polyvinyl chloride.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Pipe:
   1. In accordance with ASTM F441 and Appendix, CPVC 4120.
   2. Extruded from Type IV, Grade 1, Class 23447 material in accordance with ASTM D1784.
   3. Schedule 80, unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.

4. Manufacturers: One of the following or equal:
    a. Charlotte Pipe and Foundry Co.
    b. Eslon Thermoplastics, Inc.
    c. GF Harvel.
    d. Spears Manufacturing Co.
    e. Chemtrol.

C. Fittings:
1. In accordance with ASTM F438 or ASTM F439 for pressure fittings, as appropriate to the service and pressure requirement.
2. Same material as the pipe and of equal or greater pressure rating.
3. Supplied by pipe manufacturer.

D. Solvent cement:
1. In accordance with ASTM F493.
2. Manufacturers: The following or equal:
    a. IPS Corp.
3. Certified by the manufacturer for the service of the pipe.
4. Primer: As recommended by the solvent cement manufacturer.

E. Unions 2-1/2 inches and smaller:
1. Socket end screwed unions.

F. Unions 3 inches and larger:
1. Socket flanges with 1/8-inch full-face soft EPDM gasket.

2.02 SOURCE QUALITY CONTROL

A. Mark pipe and fittings in accordance with ASTM F441.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Protect from sunlight, scoring, and distortion.

B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.

C. Store and handle as recommended by manufacturer in published instructions.

3.02 INSTALLATION

A. General:
1. Install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe.
    a. Do not thread pipe.
3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of piping:
   1. Clean dirt and moisture from pipe and fittings.
   2. Bevel pipe ends in accordance with manufacturer's instructions with chamfering tool or file.
      a. Remove burrs.
   3. Use solvent cement and primer formulated for CPVC.
   4. Use primer on pressure and non-pressure joints.
   5. Do not solvent weld joints when ambient temperatures are below 40 degrees Fahrenheit or above 90 degrees Fahrenheit unless solvent cements specially formulated for these conditions are utilized.

3.03 FIELD QUALITY CONTROL

A. Test as specified in Section 15052 - Common Work Results for General Piping and Section 15956 - Piping Systems Testing.

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SECTION 15278

STEEL PIPE: EXPOSED

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel piping, joints, fittings, and fabricated steel piping fittings and specials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.3 - Malleable-Iron Threaded Fittings: Classes 150 and 300.
   3. B16.5 - Pipe Flanges and Flanged Fittings.
   4. B16.9 - Factory-Made Wrought Buttwelding Fittings.
   5. B16.12 - Cast Iron Threaded Drainage Fittings.

C. American Water Works Association (AWWA):
   1. C200 - Steel Water Pipe 6 Inches and Larger.
   2. C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe: 4 inches and Larger-Shop Applied.
   3. C206 - Field Welding of Steel Water Pipe.
   4. C207 - Standard for Steel Pipe Flanges for Waterworks Service-Sizes 4 inches Through 144 inches.
   5. C208 - Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   6. C210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
   7. C222 - Polyurethane Coatings and Linings for Steel Water Pipe and Fittings.
   8. C606 - Standard for Grooved and Shouldered Joints.
   9. M11 - Steel Pipe: A Guide for Design and Installation.

D. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Casting.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
   4. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. A536 - Standard Specification for Ductile Iron Castings.
   7. C33 - Standard Specification for Concrete Aggregates.
   8. C150 - Standard Specification for Portland Cement.

9. C205 - Standard Specification for Processing Additions for Use in the Manufacture of Hydraulic Cements.
10. D297 - Standard Test Methods for Rubber Products-Chemical Analysis.
11. D395 - Standard Test Methods for Rubber Property-Compression Set.
12. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
13. D471 - Standard Test Methods for Rubber Property-Effect of Liquids.
14. D573 - Standard Test Methods for Rubber -Deterioration in an Air Oven.
15. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
16. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
17. D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
18. E165 - Standard Practice for Liquid Penetrant Testing for General Industry.

E. NSF International (NSF):
1. 61 – Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Manufacturer's qualifications.
1. Manufacturer qualifications and list of projects using the specified material: 5 years minimum.

D. Manufacturer's Quality Assurance Manual:
1. Submit manufacturer's coating and lining application quality assurance manual to Engineer prior to beginning coating application.
    a. Strict conformance to the requirements of the manual will be required.
    b. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.

E. Shop drawings:
1. Details of fittings and specials showing thickness and dimensions of plates.
2. Details of welds and materials.
3. Listing of proposed services and locations for use of grooved joint type piping.
4. Tabulated layout schedules for cement-mortar lined and coated steel pipe.
5. Grooved joint piping fittings, gaskets, and couplings.
6. Grooving of pipe and fittings.

F. Calculations:
1. Submit calculations prepared and stamped by a professional engineer licensed in the State of Texas. The calculations shall be based on the requirements defined in this Section.
2. Design calculations: Wall thicknesses for external loading, special loading, internal pressure, and other necessary design cases.

G. Certificates of Compliance: Cement-mortar lined and coated steel pipe.

H. Mill certificates.

I. Test reports: Rubber gaskets.

1.04 QUALITY ASSURANCE

A. Applicable standards:
   1. Steel pipe larger than 12 inches diameter shall conform to the following standards, as complemented and modified in this Section:
      a. Steel pipe: AWWA C200.
      b. Fittings and specials: AWWA C208.
      c. Reinforcement of fittings and specials: AWWA M11.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Design criteria for pipe and pipe fittings: In accordance with AWWA M11 with the following modifications:
      a. Wall thickness: Thicker of the thickness specified in Section 15052 - Common Work Results for General Piping Pipe Schedule, and the following thickness:
         1) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
         2) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
         3) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.
      b. Inside diameter of unlined pipe: Nominal.
      c. Inside diameter of lined pipe: As measured from face to face of liner, but not less than nominal.
      d. Deflection of underground pipe inside diameter: Maximum 2 percent under trench load of H-20 live load in accordance with AASHTO specifications.
      e. Working stress of steel: Maximum 50 percent of yield stress.
      f. Contractor shall develop and submit calculations to determine the steel pipe and fitting wall thickness and design requirements according to the requirements of this specification.

2.02 MATERIALS

A. The requirements for steel piping materials used in plumbing systems are found in Section 15400 - Plumbing Systems.

B. Steel pipe:
   1. Type, pipe 6 inches and smaller: ASTM A53, black or galvanized, seamless or straight seam electric resistance welded. Minimum Schedule 40.
   2. Type, from 6 to 12 inches: ASTM A53, black or galvanized pipe, seamless or straight seam electric resistance welded. Minimum Schedule 20.
   3. Type, larger than 12 inches: AWWA C200, without butt strap, riveted, or swaged joints; wall thickness as specified.

4. Type, 24 inches and larger, with grooved type couplings and wall thickness less than 1/2-inch: Provided with stub ends, sized as follows, for grooves.
    a. Thickness: As recommended by coupling manufacturer, but not less than 1/2-inch.
    b. Length: Width of coupling plus 1 inch, but not less than 6 inches.
5. Type for liquid or gaseous dry chlorine: ASTM A106, Grade A, Schedule 80, assembled with 300 pounds per square inch malleable iron fittings and ammonia type flanges.

C. Steel pipe fittings:
    1. Screwed fittings:
        a. Malleable iron: ASME B16.3, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe.
        b. Cast iron drainage: ASME B16.12, galvanized in accordance with ASTM A153 where used with galvanized pipe.
    2. Flanged fittings:
        a. Type for 12-inch and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; or ASME B16.5, steel, 150 pounds, galvanized in accordance with ASTM A153 where used with galvanized pipe.
        b. Type for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207 and AWWA C208, fabricated from flanges and steel pipe, respectively.
        c. Companion flanges for 4 inches and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; ASME B16.5, steel, 150 pounds, slip-on or welding neck; or ammonia type for use on chlorine liquid or gas piping.
        d. Companion flanges for larger than 4 inch to and including 12-inch pipe: ASME B16.5, slip-on or welding neck type.
        e. Companion flanges for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207, steel plate or raised hub type.
        f. Weld flanges to pipe or fittings before applying lining.
        g. Machine flanges or provide tapered filler for changes in grade or to slope lines for drainage.
        h. Flange bolts: As specified in Section 15052 - Common Work Results for General Piping.
        i. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.
    3. Welding fittings:
        a. Welding fittings for piping 8 inches and less in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, standard wall, or standard weight.
        b. Welding fittings for piping larger than 8 inches in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, or, at the option of the Contractor, made up out of sections of pipe welded together, except where smooth bends are indicated for air lines.
        c. Fittings made up of sections of pipe welded together shall be made of pipe of at least the same wall thickness as the pipe with which used, and bends shall be miter bends, fabricated in accordance with AWWA C208 and as supplemented by AWWA M11. Welding of these made-up fittings shall be in accordance with AWWA C206.

1) Design and fabricate outlets and 4 branch fittings in accordance with AWWA M11.
2) Bends may be welded to adjacent pipe sections.
a) Bends shall be manufactured of the following number of pieces:
(1) Bends from 0 to 30 degrees angle, 2 pieces.
(2) Bends from 30 to 45 degrees angle, 3 pieces.
(3) Bends from 45 to 67-1/2 degrees angle, 4 pieces.
(4) Bends from 67-1/2 to 90 degrees angle, 5 pieces.

4. Grooved joint fittings:
a. Fittings for grooved joint steel piping: Rigid-grooved type, and as follows:
1) Grooves: Cut; rolled grooves are not acceptable.
2) Couplings: Cast in 2 or more segments of ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
3) Bolts and nuts: As specified in Section 15052 - Common Work Results for General Piping.
4) Gaskets: Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness.
a) Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
b) Gaskets for use with cement-mortar lined steel piping shall be captured between the ends of the pipe to protect exposed metal from corrosion, and shall be made of nitrile in accordance with ASTM D2000, Line Call Out 2CA615A25B24.
5) Perform grooving of the pipe wall only on standard or heavier schedule weight pipe.
a) For pipe with wall thickness less than standard weight, weld a shouldered end on the pipe in accordance with AWWA C606.
b) Fabricated pipe, pipe in accordance with AWWA C200, shall have shouldered ends welded onto the pipe.
c) Shoulder: Type B or D in accordance with AWWA C606.
6) Couplings and grooving:
a) Manufacturers: One of the following or equal:
(1) Gustin-Bacon Piping Products.
(2) Victaulic Co.

b. Fittings for grooved joint piping: Ductile iron in accordance with ASTM A536, Grade 65-45-12, or malleable iron in accordance with ASTM A47, Grade 32510, and as follows:
1) Where cast fittings are not made, standard fittings including large diameter elbows shall be made of forged steel in accordance with ASTM A105, Grade B with 0.375 inch wall thickness, or shall be standard segmentally welded fittings fabricated of Schedule 40 carbon steel pipe.
a) Grooves:
(1) Manufacturers: One of the following or equal:
(a) Gustin-Bacon Piping Products.
(b) Victaulic Co.
2) Fittings for grooved joint piping shall be furnished by the manufacturer of the grooved joint material.
3) Fittings for grooved joint piping shall be for rigid-grooved type joints.

4) Connection to flanged units shall be by means of flange to grooved joint adapters.
    a) Where the flanged to grooved joint adapters interfere with the operation of adjacent valves, pumps, or other items, the connection shall be by means of a spool with one end flanged and the other grooved, long enough to prevent interference with adjacent valves, pumps, or other items.

D. Steel pipe lining and coating.
1. General:
    a. Except where otherwise indicated on the Drawings, lining and coating for steel pipe shall be as specified in Section 15052 - Common Work Results for General Piping.

E. Fabricated steel piping fittings and specials:
1. General: Specified in this Section are the design and fabrication of fabricated steel piping fittings and specials, which include elbows, branches, nozzles, manifolds, headers, heads, collars, stiffeners, reinforcements, and other steel fabrications relating to steel piping, but shall not include steel pipe.
2. Design:
    a. Contractor shall design and detail fittings and specials.
        1) Design: In accordance with the recommended procedures in AWWA Manual M11, as complemented and modified in this Section.
        2) Nozzles: Reinforced in accordance with recommended practice in AWWA M11, Steel Pipe Manual.
        3) Design reinforcing for fittings and specials for the specified test pressure.
        4) Fittings shall conform in dimension to AWWA C208, complemented with the provisions specified in this Section.
        5) The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.
    b. The thickness of pipe, large elbows, and headers, except header nozzles, shall be the thicker of:
        1) The thickness designed in accordance with the design methods specified in this Section.
        2) The thickness specified in Section 15052 - Common Work Results for General Piping Pipe Schedule, or as required by the Contractor’s calculations.
        3) The following thicknesses:
            a) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
            b) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
            c) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.
    c. Elbows shall be of the number of pieces as specified in this Section, and thickness of material shall conform to thickness of pipe or manifold shells specified.
    d. Ends of fittings to be welded to pipe shall be beveled for welding.
3. Fabrication:
    a. Shop fabricate steel piping fittings and specials in units as long as practicable for safe hauling and installation. Minimize number of field welds.

b. Fabricate fittings and specials to uniform lengths with proper end clearance for the specified types of joint or attachment.
c. Fabricate fittings and specials to allow field assembly without cutting or special work.
d. Where specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping or indicated on the Drawings, the inside of fabricated steel manifolds and other fittings and specials shall receive a cement-mortar lining in accordance with AWWA C205.
    1) Reinforce lining for piping 24 inches in diameter and larger with wire fabric.
e. Do not weld flanges to nozzles until the nozzles and reinforcements are completely welded to the header.
    1) Accurately space and align flanges so that when connections have been made there will be no stress on the header, piping, or equipment. Properly locate and align equipment.

4. Dished heads:
    a. Dished heads on 84 inch diameter and smaller manifolds: 1 piece (seamless) spherically dished (torispherical) heads.
        1) Larger heads may be seamed.
    b. Dish radius: Same dimension as the outside diameter of the head measured at skirt.
    c. Skirt face length: Not less than 3 inches.
    d. Design heads in accordance with recommended practice in AWWA M11, Steel Pipe Manual.
5. Testing: No shop testing will be required for manifolds or piping connected thereto.

F. AWWA C200 steel pipe and fittings design and fabrication:
1. General:
    a. Applicable standards: AWWA C200 steel pipe shall conform to the standards specified in General of this Section.
    b. Identification marks: Provide identification marks in accordance with AWWA C200. These marks shall be stenciled or otherwise shown at the top of the piping items exterior, including the following information:
        1) Name or trademark of the manufacturer.
        2) Date of manufacture of the item.
        3) Internal diameter in inches.
        4) Number of the item, sequential from initial to end station.
    c. Diameter designation: The pipe diameter specified in the Specifications and indicated on the Drawings shall be the clear inside diameter after application of the cement-mortar lining with a tolerance of plus 0 inch and minus 1/4 inch.
2. Design:
    a. Pipe and fittings shall be designed by Contractor.
    b. Design: In accordance with the recommended procedures in AWWA Manual M11, as complemented and modified in this Section.
    c. Thicknesses of pipe, fittings and specials shall be the thicker of:
        1) The thickness designed in accordance with the design methods specified in this Section.
        2) The thickness specified in Section 15052 - Common Work Results for General Piping Pipe Schedule.

3) The following thicknesses:
    a) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
    b) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
    c) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.

d. The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.
e. Break longitudinal and girth seams for straight seam pipe shall be no greater in number than would be required for the fabrication of pipe with 96-inch by 120-inch steel plates.
    1) Break longitudinal seams at the girth seams.
f. Calculate earth loads using the following formula:

$$W = 192 \times H \times B$$

wherein the various terms shall have the following meaning:

W: Earth load, pounds per linear foot of pipe.
H: Height of fill over the pipe, feet.
B: Outside diameter of the pipe, feet.
x: Mathematical symbol for multiplication.

g. Add AASHTO's H-20 loading to earth loads.
h. Design pipe, fittings and specials for a deflection, under external loads, not to exceed 2 percent of the diameter.
    1) Stiffness computations shall not consider the effect of the cement-mortar lining and coating.
    2) Calculate deflection using the Spangler formula and the following values:
        a) Bedding constant K = 0.100.
        b) Modulus of soil reaction E' = 700 pounds per square inch.
        c) Deflection lag constant D_1 = 1.00.
i. Where piping is designated to be flanged or welded in order to restrain thrust, the design of the cylinder and flange or welded joint shall take into account the effect of stresses caused by thrust loads.
j. Steel cylinder shall be subject to no more than the lesser of 15,000 pounds per square inch or 50 percent of the steel yield stress.

3. Materials:
    a. Coatings and linings: As required in Section 15052 - Common Work Results for General Piping.
    b. Gaskets shall be as specified in Section 15052 - Common Work Results for General Piping and meet the following requirements:
        1) Minimum tensile strength, tested in accordance with ASTM D412, between 2,000 and 2,700 pounds per square inch.
        2) Minimum elongation, tested in accordance with ASTM D412, between 350 and 400 percent.
        3) Shore A durometer hardness, tested in accordance with ASTM D2240, between 50 and 65.
        4) Specific gravity, tested in accordance with ASTM D297, between 0.90 and 1.50.

5) Maximum compression set, tested in accordance with Method B of ASTM D395, 20 percent.
6) Maximum tension strength loss, tested in accordance with ASTM D573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
7) Maximum elongation loss, tested in accordance with ASTM D573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
8) Maximum absorption, tested in accordance with ASTM D471 at 48 hours, 70 degrees Centigrade, in air, 5 percent.

4. Joints and connections:
   a. Joints:
      1) Except as otherwise specified or indicated on the Drawings, provide lap welded or bell and spigot type joints with rubber gaskets for pipelines 54 inches and smaller.
      2) Butt-strap joints shall be used only where required for closures or where indicated on the Drawings.
      3) The joints furnished shall have the same or higher-pressure rating as the abutting pipe.
   b. Connections:
      1) Connections to existing systems shall be made using a flange isolation joint.
      2) If an existing pipeline or facility does not include a flange at or near the connection point:
         a) An isolation flange shall be placed in the first length of pipe.
         b) A butt-strap joint shall be used to connect the first length of pipe to the existing pipeline.
   c. Bell and spigot joint rings: Rolled Carnegie shape M-3516.
   d. Lap welded joints:
      1) Double fillet weld lap welded joints shall be welded on the inside and outside of the joint.
      2) Lap joints prepared for electric field welding shall be in accordance with AWWA C206.
      3) Joint forming:
         a) Joint geometry and joint field weld will be such that no part of any field weld will be closer than 1 inch to the nearest point of tangency to the bell radius.
         b) Bell ends shall be formed by and expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape.
      4) Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.
   e. Butt-strap joints: Butt-strap joints where used or required, shall be:
      1) A minimum of 10 inches wide.
      2) The same thickness as the pipe wall.
      3) Provide for a minimum of 2-inch lap at each pipe joint.
      4) Double fillet weld each side of joint on the inside and outside of the joint.

f. Flanges: AWWA C207, Class D, steel ring, and as follows:
    1) Match pipe flanges to the valve flanges:
        a) At flanged joints connecting to valves, provide a steel pipe section without rod reinforcing and not less than 24 inches in length.
        b) Apply cement-mortar lining and coating to the steel pipe section.
    2) Flange bolts: As specified in Section 15052 - Common Work Results for General Piping.
    3) Gaskets: As specified in Section 15052 - Common Work Results for General Piping.

5. Fabrication:
    a. Shop coat of primer: Flanges and portions of pipe not covered with cement-mortar shall be given a shop coating of primer.
    b. Bend radii of fittings: Not less than 2.5 times the nominal diameter in accordance with AWWA C208.

2.03 COATING AND LINING - GENERAL

A. Coating and lining shall be as indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping.

B. Extend pipe coatings for underground piping 6-inches above finished grade or 3-inches above finished floor, and neatly terminate.

C. As specified in Section 01600 - Product Requirements.

D. Prepare, install, and repair in accordance with manufacturer's requirements.

E. Contractor is responsible for:
1. That coating selected is suitable for the application conditions anticipated, such as temperature, humidity, etc.
2. Managing the project schedule to allow adequate cure time before backfill or immersion based on surface temperatures at the time of application.

PART 3 EXECUTION

3.01 INSTALLATION

A. The requirements for installation of steel pipe used in plumbing systems are found in Section 15400 - Plumbing Systems.

B. Joints:
1. Steel pipe joints shall be screwed, welded, flanged, grooved, or made with flexible joints. The type of joint for piping is specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.
2. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means necessary to allow ready assembly and disassembly of the piping.

3. Unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping, pipe joints shall be as follows:
    a. Pipe smaller than 2 inches in nominal diameter shall have screwed joints or flexible couplings.
    b. Pipe 2 inches to 4 inches in nominal diameter shall have screwed joints, flanged joints, welded joints, or joints made with flexible couplings.
    c. Pipe larger than 4 inches in nominal diameter shall have flanged joints, welded joints, or joints made with flexible couplings.

C. Screwed joints:
1. Perform threading with clean, sharp dies.
    a. Wavy, rough, or otherwise defective pipe threads are not acceptable.
2. Make screwed joints tight and clean with an application of Teflon™ tape or approved paste compound applied to the male threads only, except as follows:
    a. Make up liquid and dry chlorine lines, and liquefied petroleum gas lines, with litharge and glycerin.
3. Provide railroad type unions with bronze-to-iron seat, galvanized where used with galvanized pipe.
    a. Flanged joints may be used instead of unions.

D. Flanged joints:
1. In flanged joints, flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place.
2. Attach slip-on flanges to pipe by 2 fillet welds, in accordance with AWWA C207.
3. Secure welding neck flanges with full penetration butt welds without backing rings.
    a. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment.

E. Welded joints:
1. Welded joints shall be electric welded in accordance with AWWA C206.
2. Welders shall be qualified pursuant to the provisions of AWWA C206.
    a. Welders' testing shall be at the Contractor's expense, including cost of test nipples, welding rods, and equipment.
3. Do not weld galvanized pipe.

F. Grooved joints:
1. Piping with grooved joints shall be installed where indicated on the Drawings and may be installed in place of flanged piping and screwed piping, except that grooved joint piping shall not be used in the following installations:
    a. In underground and underwater installations.
    b. In piping subject to test pressures of 150 pounds per square inch gauge, or more.
    c. In steam and gas piping.
    d. In sludge and scum piping designed to be steam cleaned.
2. Assemble in accordance with manufacturer's published instructions.
3. Support grooved-end pipe in accordance with manufacturer's recommendations. In addition, provide at least 1 support between consecutive couplings.

3.02 DEFECTS IN COATINGS EXCEPT CEMENT MORTAR

A. Engineer will identify defective coating to be field repaired in accordance with the applicable AWWA standard.
   1. Pipe joints exceeding the following defect maximum will be rejected.
      a. Minor defects:
         1) No more than 1.5 per 100 square feet of surface area.
         2) 2 or more minor repairs within an 8-inches diameter circle will be considered a single repair.
         3) Repairs for adhesion testing will not be included in the total number of repairs.
         4) Repair in accordance with manufacturer's requirements.
      b. Major defects:
         1) No more than 3 major repairs on each pipe joint.
         2) No more than 30 percent repairs on the pipe surface area with defects.
   2. Minor repairs:
      a. Repairs less than 8-inches in the greatest dimension.
      b. Repair in accordance with manufacturer's requirements.
   3. Major repairs:
      a. Repairs that exceed 8-inches in the greatest dimension.
      b. Repair in accordance with manufacturer's requirements.

3.03 CEMENT MORTAR

A. Lining:
   1. Field applied interior joint lining:
      a. Field applied lining shall be of the same density, smoothness, and thickness as shop applied lining.
      b. After the backfill has been completed to final grade, fill interior joint recess with tightly packed cement mortar.
         1) Trowel flush with the interior surface with no indentation or projection of the mortar exceeding 1/16-inch.
         2) Remove excess cement mortar.

3.04 PLURAL COMPONENT EPOXY

A. Joints:
   1. Field applied coating or lining shall be of the same density, smoothness, and thickness as shop applied coating or lining.
   2. Comply with same application requirements as shop applied coating or lining.
      a. Provide heating and/or dehumidification equipment as required to meet the environmental conditions necessary for proper coating application.

3.05 PLURAL COMPONENT POLYURETHANE

A. Joints:
   1. Field applied coating or lining shall be of the same density, smoothness, and thickness as shop applied coating or lining.
   2. Comply with same application requirements as shop applied coating or lining.
      a. Provide heating and/or dehumidification equipment as required to meet the environmental conditions necessary for proper coating application.

3.06 FIELD QUALITY CONTROL

A. Field test fabricated steel manifolds with the pipe to which they connect.

B. Weld testing:
   1. Liquid penetrant testing:
      a. As soon as possible after welding of pipeline joints, all fillet welds shall be tested by the liquid penetrant inspection procedure in accordance with ASTM E165 under Method “B” and “Leak Testing”.
      b. Chip out defects, rebell, and retest.
         1) Upon retest, the repaired area shall show no leaks or other defects.

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SECTION 15282

COPPER TUBE: SEAMLESS, ASTM B280

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Copper tube-seamless, ASTM B280.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B32 - Standard Specification for Solder Metal.
   2. B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   3. B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fitting.

B. International Association of Plumbing and Mechanical Officials (IAPMO):
   1. IS 3 - Installation Standard for Copper Plumbing Tube, Pipe, and Fittings.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

PART 2 PRODUCTS

2.01 MATERIALS

A. Seamless copper tubing for air conditioning and refrigeration field service:
   1. Type: ASTM B280, USN Alloy C12200, outside diameter sized, minimum wall thickness in accordance with ASTM B280.
   2. Fittings: Solder fittings or brass flared fittings.
   3. ASTM B280 copper tubing may be bundled into groups of parallel or spirally cabled tubes with a plastic sheath.
   4. Solder: In accordance with ASTM B32, Alloy Grade Sb5.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Support copper tubing as specified in Sections 15061 - Pipe Supports and 15062 - Preformed Channel Pipe Support System.

2. Clean copper lines with high-pressure air after first disconnecting piping at instruments, filters, pressure reducers, valve operators, and other special devices.
3. Install copper pipe in accordance with IAPMO IS 3.

B. Installation of copper tubing:
1. Install copper tubing in accordance with ASTM B828 and IAPMO IS 3.
2. Install copper tubing in straight runs, supported at intervals close enough to avoid sagging.
3. Make cuts square with a tubing cutter or with a 32-tooth hacksaw.
   a. Provide a sizing tool to correct distortions.
4. Ream the inside of the tubing and remove burrs from the outside, holding the end of the tubing downward and preventing chips and fillings from entering the tubing.
5. Perform flaring with a flare block and yoke type screw feed flaring tool:
   a. After removing the tubing from the flare block, inspect both surfaces of the flare for splits, cracks, or other imperfections.
   b. Where there are imperfections, cut off the imperfect flare and prepare a new flare.

3.02 FIELD QUALITY CONTROL

A. Testing: Test copper lines in the same manner as the piping system to which they connect.

END OF SECTION

SECTION 15286

STAINLESS STEEL PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Stainless steel piping and tubing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
   3. B16.11 - Forged Fittings, Socket-Welded and Threaded.
   4. B31.3 - Process Piping.
   5. B36.19 - Stainless Steel Pipe.

B. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code - Stainless Steel.

C. ASTM International (ASTM):
   1. A182 - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 - Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High Pressure or High Temperature Service, or Both.
   4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   8. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   9. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   10. A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   11. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
   12. A744 - Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.

13. A774 - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Services at Low and Moderate Temperatures.
14. A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
15. A789 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service.
16. A790 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe.
17. A928 - Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal.
18. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
19. B622 - Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube.
20. B912 - Standard Specification for Passivation of Stainless Steels Using Electropolishing.
21. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

D. NSF International (NSF):
1. Standard 61 - Drinking Water System Components - Health Effects.

1.03 DESIGN REQUIREMENTS

A. Piping layout: Lay out and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints are minimized.
1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
2. Where joints and couplings are specifically indicated on the Drawings, design and shop-fabricate piping sections utilizing the joint or coupling illustrated at the locations shown.
3. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.

B. Shop fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field assembly:
1. Field welding is prohibited.
2. Assemble shop-fabricated piping in the field using the joints designed into the piping layout or by using flexible couplings.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Shop drawings:
   1. Detailed layout drawings:
      a. Dimensions and alignment of pipes.
      b. Location of valves, fittings, and appurtenances.
      c. Location of field joints.
      d. Location of pipe hangars and supports.
      e. Connections to equipment and structures.
      f. Location and details of shop welds.
   2. Thickness and dimensions of fittings and gaskets.
   3. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   4. Material specifications for pipe, gaskets, fittings, and couplings.
   5. Data on joint types and components used in the system including stub ends, backing flanges, flanged joints, grooved joint couplings and screwed joints.

D. Field welding references:
   1. Welder and weld operator qualification certificates and welding procedures.

PART 2 PRODUCTS

2.01 STAINLESS STEEL PIPE

A. General:
   1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall thickness:
   1. As specified in the Pipe Schedule within the Drawings.
   2. Piping 3 inches in nominal diameter and greater:
      a. For general service applications with pressures less than 250 pounds per square inch gauge, pipe diameter 24-inches or less, minimum wall thickness corresponding to Schedule 10S.
   3. Piping less than 3 inches in nominal diameter:
      a. Piping with threaded or grooved joints:
         1) Minimum wall thickness corresponding to Schedule 40S.
      b. Piping with Vic-Press joints:
         1) Minimum wall thickness corresponding to Schedule 10S.
   4. Piping with threaded or grooved joints:
      a. For general service applications with pressures less than 250 pounds per square inch gauge, minimum wall thickness corresponding to Schedule 40S.

C. Piping material and manufacturing:
   1. Comply with the requirements outlined in the following table:

D. Fittings for piping 3 inches in nominal diameter and greater:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM A774.
   3. Wall thickness of fitting: In accordance with ASME B36.19 for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.

5. Dimensional standards:
    a. Fittings with weld ends: In accordance with ASME B16.11.
    b. Fittings with flanged ends: In accordance with ASME B16.5, Class 150.

E. Fittings for piping less than 3 inches in diameter:
1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
2. Manufacturing standard: In accordance with ASTM A403, Class WP.
3. Wall thickness and dimensions of fitting: In accordance with ASME B16.11 and as required for the schedule of pipe specified.
4. End configuration: As needed to comply with specified type of joint.
5. Forgings in accordance with ASTM A182, or barstock in accordance with ASTM A276. Match forging or barstock material to the piping materials.

F. Piping joints:
1. Joint types, piping greater than 2 inches in diameter, general:
    a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.
    b. Where type of joint is not specifically indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping, Piping Schedule, design and shop-fabricate piping sections utilizing any of the following joint types:
        1) Piping stub ends with backing flanges.
        2) Welded joints.
        3) Flanged joints.
    c. Joints at valves and pipe appurtenances:
        1) Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends.
        2) Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using piping stub ends with backing flanges, flanged coupling adapters or flanged joints.
            a) Flexible couplings and flanged coupling adapters: Provide stainless steel construction with materials matching the piping system, and conforming to requirements as specified in Section 15121 - Pipe Couplings and External Joint Restraints.
2. Joints in piping 2 inches in diameter and smaller: Flanged, grooved, or screwed with Teflon™ tape thread lubricant, as scheduled in the Drawings.
3. Welded joints:
    a. Pipe 12 inches and larger in diameter: Automatically weld joints using gas tungsten-arc procedures.
    b. Piping 4 inches through 12 inches in diameter: Double butt welded joints.
    c. Piping less than 4 inches in diameter: Single butt-welded joints.
    d. Mark each weld with a symbol that identifies the welder.
4. Flanged joints: Conforming to the requirements in accordance with ASME B16.5, Class 150.
5. Piping stub ends and backing flanges for pipe 3 inches and larger:
    a. Piping stub ends: Cast stainless steel to match the pipe material with machined gasket and wetted surfaces of stub ends free of crevices, pits, cracks and protrusions.
        1) Manufacturers: The following or equal:
            a) Alaskan Copper Works, Figure SK-38.

b. Backing flanges: Forged or plate stainless steel (type to match pipe material) with drilled bolt patterns in accordance with ASME B16.1, Class 125 or ASME B16.5, Class 150, 300 or 600, as scheduled.
    1) Manufacturers: The following or equal:
        a) Alaskan Copper Works, Figure SK-39 (tube) or SK-39P (pipe).
c. Stub ends and backing flanges are not allowed for use with wafer style or lugged style valves.

6. Flanges for Schedule 40S and Schedule 80S pipe:
    a. Provide forged stainless steel (type matching piping system) welding neck flanges or slip-on flanges in accordance with ASME B16.5 Class 150**.**
    b. Material: In accordance with ASTM A182.

G. Gaskets:
1. Ozone and oxygen service: TFE sheet.
2. Aeration air service: As specified in Section 15052 - Common Work Results for General Piping.
3. All other service applications: EPDM, nitrile, or other materials compatible with the process fluid.
    a. Drinking water applications: NSF Standard 61 compliant materials only.

H. Bolts for flanges and stub end/backing flanges:
1. Bolts and nuts: Type 316 stainless steel in accordance with ASTM A193 heavy hex head.
    a. Bolt length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut.
    b. Nuts: In accordance with ASTM A194 heavy hex pattern.

I. Fabrication of pipe sections:
1. Welding: Weld in accordance with ASME B31.3.
2. Weld seams:
    a. Full penetration welds, free of oxidation, crevices, pits and cracks, and without undercuts.
    b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
    c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
    d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

J. Cleaning (pickling) and passivation:
1. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.
2. Clean (pickle) and passivate in accordance with ASTM A380 or A967.
    a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible.
        1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.
    b. Passivation treatments with citric acid are not allowed.
3. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.

2.02 STAINLESS STEEL TUBING

A. Stainless steel tubing:
   1. Seamless tubing made of Type 316L stainless steel and in accordance with ASTM A269, wall thickness not less than 0.035 inch.

B. Fittings: Swage ferrule design:
   1. Components made of:
      a. Type 316 stainless steel.
   2. Double acting ferrule design, providing both a primary seal and a secondary bearing force.
   3. Flare type fittings are not acceptable.
   4. Manufacturers: One of the following or equal:
      a. Crawford Fitting Co., Swagelok.
      b. Hoke, Gyrolok.
      c. Parker, CPI.

C. Valves for use with stainless steel tubing:
   1. Ball type valves with swage ends to match tubing diameter.
   2. Constructed from:
      a. Type 316 stainless steel with TFE seats.
   3. Manufacturers: The following or equal:
      a. Crawford Fitting Co., Swagelok.

2.03 SPARE PARTS

A. None

2.04 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied are in accordance with ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied are in accordance with ASTM A774.
   1. Supplementary testing is not required.

D. Thoroughly clean any equipment before use in cleaning or fabrication of stainless steel.

E. Storage: Segregate location of stainless steel piping from fabrication of any other piping materials.

F. Shipment to site:
   1. Protect all flanges and pipe ends by encapsulating in dense foam.
   2. Securely strap all elements to pallets with nylon straps. Use of metallic straps is prohibited.
   3. Cap ends of tube, piping, pipe spools, fittings, and valves with non-metallic plugs.

4. Load pallets so no tube, piping, pipe spools, fittings, or valves bear the weight of pallets above.
5. Notify Engineer when deliveries arrive so Engineer may inspect the shipping conditions.
6. Engineer may reject material due to improper shipping methods or damage during shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping in such a manner as not to impart strain to connected equipment.

B. Slope horizontal lines so that they can be drained completely.

C. Provide valve drains at low points in piping systems.

D. Install eccentric reducers where necessary to facilitate draining of piping system.

E. Provide access for inspection and flushing of piping systems to remove sediment, deposits, and debris.

3.02 FIELD ASSEMBLY OF SHOP-FABRICATED PIPING SECTIONS

A. Join shop-fabricated piping sections together using backing flanges, flexible couplings, flanged coupling adapters, grooved couplings, or flanges.

3.03 FIELD QUALITY CONTROL

A. Test piping to pressure and by method as specified in Section 15052 - Common Work Results for General Piping.
   1. If pressure testing is accomplished with water:
      a. Use only potable quality water.
      b. Piping: Thoroughly drained and dried or place immediately into service.

B. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

3.04 PROTECTION

A. Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work.
   1. Use handling methods and equipment to prevent damage to the coating, include the use of wide canvas slings and wide padded skids.
   2. Do not use bare cables, chains, hooks, metal bars, or narrow skids.
   3. Store stainless steel piping and fittings away from any other piping or metals. Storage in contact with ground or outside without projection from bad weather is prohibited.

4. Protect stainless steel piping and fittings from carbon steel projections (when grinding carbon steel assemblies in proximity) and carbon steel contamination (do not contact stainless steel with carbon steel wire brush or other carbon steel tool).

END OF SECTION

SECTION 15293

DOUBLE CONTAINMENT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Double contained piping systems and accessories.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B31.3 - Process Piping Code.

B. ASTM International (ASTM):
   1. D2564 - Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   2. D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
   3. D2855 - Practice for Making Solvent - Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
   4. D2996 - Standard Specification for Filament-Wound Fiberglass (glass-fiber-reinforced thermosetting-resin) Pipe.
   5. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

C. German Institute for Standardization (DIN):
   1. PAS 1075 - Pipes Made from Polyethylene for Alternative Installation Techniques - Dimensions, Technical Requirements and Testing.

D. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. PE 100-RC: High-density polyethylene with a cell classification of PE445584C.

B. NEMA: Type 4X enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Product data.

B. Manufacturer’s published installation instructions.

C. Expansion joint design information.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Materials:
   1. Inner (carrier) pipe: As specified in Pipe Schedule within the Drawings.
   2. Outer (containment) pipe: As specified in Pipe Schedule within the Drawings.
   3. Compatible for continuous exposure to chemical service as specified in Section 15052 - Common Work Results for General Piping and maximum pressure equal to the test pressure.

B. Prefabricated fittings:
   1. Prefabricated fittings consisting of an inner (carrier) pipe elbow totally enclosed, secured, and spaced in an outer (containment) pipe elbow.
   2. Split fittings requiring field cutting, welding or joining shall not be used.

C. Spacers:
   1. Provide spacers on inner pipe to control sagging within containment pipe.
      a. Design and place spacers to withstand loads of the filled pipe and loads due to thermal expansion.
      b. Provide spacers free of sharp edges and attached to the carrier pipe.

D. Expansion loops:
   1. Provide expansion loops as required to compensate for expected thermal expansion for an ambient temperature range as specified in Section 01612.

E. Access ports:
   1. Provide access ports for ease of installation, start-up, and maintenance of piping.
   2. Access ports components:
      a. A tee fitting in the secondary containment piping.
      b. A 6-inch diameter riser pipe.
      c. A bolted blind flange cover.
   3. Locate access ports at each low point.

F. Leak detection:
   1. Provide leak detection observation tee at each low point as indicated on the Drawings.
   2. Sensor:
      a. Level float.
      b. Non-penetrating, non-contacting with media.
   3. Control panel:
      a. NEMA Type 4X PVC or polycarbonate enclosure.
      b. 120V input.
      c. Dry contact output.
      d. Keyed on/off switch.
      e. LCD display that shows date, time, and type of alarm:
         1) Store date in non-volatile memory.
   4. Provide special leak proof fittings to enclose all inner pipe fittings and yet allow any leaks to flow to the low point.

2.02 DOUBLE CONTAINMENT PVC PIPING SYSTEM

A. Manufacturers: One of the following or equal:
   1. Guardian Systems, a product of IPEX Inc.
   2. Pro-Lock by Asahi/America, Inc.

B. Materials:
   1. Compatible for continuous exposure to chemical service as indicated in the pipe schedule at ambient temperatures and maximum pressure equal to the test pressure.
   2. Prefabricated fittings:
      a. Prefabricated fittings consisting of an inner (carrier) pipe elbow totally enclosed and spaced in an outer (containment) pipe elbow.
      b. Split fittings requiring field cutting, welding or joining shall not be used.
   3. Inner (carrier) pipe:
      a. Provide pipe as specified in Section 15052 - Common Work Results for General Piping and Section 15230 - Plastic Piping and Tubing.
   4. Outer (containment) pipe:
      a. Provide pipe as specified in Section 15052 - Common Work Results for General Piping and Section 15230 - Plastic Piping and Tubing.

C. Design requirements:
   1. Access ports:
      a. Provide access ports for ease of installation, start-up, and maintenance of piping.
      b. Access ports components:
         1) A tee fitting in the secondary containment piping.
         2) A 6-inch diameter riser pipe.
         3) A bolted blind flange cover.
      c. Locate access ports at each low point.

PART 3 EXECUTION

3.01 DELIVERIES, STORAGE AND HANDLING OF COMPONENTS

A. Manufacturer shall deliver piping components to arrive on-site wrapped or protected to avoid damage in shipping.

B. Deliver fittings and other components to arrive on-site in boxes.

C. Pipe, fitting and other components should be stored on elevated platforms in a dry location protected from the environment.

D. Lift, support, and transport components with due care to avoid damage

3.02 INSTALLATION FOR PVC

A. Plastic piping systems:
   1. Secondary containment joints solvent cemented using heavy body-slow set made in accordance with ASTM D2855.
      a. PVC cement: In accordance with ASTM D2564.
      b. CPVC cement: In accordance with ASTM F493.

2. Install and test in accordance with manufacturer's instructions.
3. Continuously slope piping to drain to a low point.
4. Buried double containment piping:
    a. Provide tee with minimum 3-inch riser pipe to grade for inspection and access at each low point.
    b. Provide threaded cap at top of riser pipe installed in a valve box.
5. Exposed double containment piping:
    a. Provide tee with minimum 2-inch drainpipe with ball valve at each piping low point.
6. Close ends of outer containment pipe.

3.03 COMMISSIONING

A. As specified in Section 01756, 15958, and this Section.

B. Manufacturer services:
1. Provide certificates:
    a. Manufacturer’s Certificate of Source Testing.
    b. Manufacturer’s Certificate of Installation and Functionality Compliance.
2. Manufacturer’s Representative onsite requirements:
    a. Installation: 1 trip, 1 day minimum.
    b. Functional Testing: 1 trips, 1 day minimum each.
3. Training:
    a. Maintenance: 2 hours per session, 1 sessions.
    b. Operation: 1 hours per session, 1 sessions.
4. Process Operational Period.
    a. As required by Owner or Contractor.

C. Source testing: None.

D. Functional testing:
5. Test witnessing: Witnessed.
    a. Double Contained Piping Systems:
        1) Inner containment pipe:
            a) Test as specified in Section 15956 - Piping Systems Testing.
        2) Outer containment pipe:
            a) Pneumatically test the pipe at a minimum of 5 pounds per square inch and a maximum of 10 pounds per square inch air pressure for 2-1/2 hours.
            b) Soap external joints and visually inspect for leaks.
            c) Repair leaks in accordance with manufacturer's recommendations.
            d) Purge containment pipe annular space with nitrogen to remove moisture containing air following leak test.

END OF SECTION

SECTION 15294

RUBBER HOSE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hose.

1.02 SUBMITTALS

A. Product data: Manufacturer's data indicating service type, sizes, materials, and required accessories.

PART 2 PRODUCTS

2.01 HOSE

A. Hose material: Neoprene or acceptable oil resistant material suitable for a working pressure of minimum 100 pounds per square inch, gauge.

B. Size as indicated on the Drawings fit ends with appropriate combination clamped nipples and threaded ends as indicated on the Drawings.

C. Hose larger than 1-1/2 inches in size: Industrial fire hose. Provide one 50 foot long hose for each utility station (hose bib and hose rack) provided.
   1. Manufacturers: One of the following or equal:
      a. Goodyear Rubber Products Corp.
      b. Uniroyal, Inc.
      c. Goodall Rubber Co.

D. Hose 1/2-inch through 1-1/2 inch nominal diameter: General purpose hose. Provide one 75 foot long hose for each utility station (hose bib and hose rack) provided.
   1. Manufacturers: One of the following or equal:
      a. Goodyear Rubber Products Corp.
      b. Uniroyal.
      c. Goodall Rubber Co.

E. Equip and fit hose ends with appropriate combination clamped nipples and threaded ends to make up the assembly indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install hose in accordance with manufacturer's published instructions.

END OF SECTION

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SECTION 15400

PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for materials and installation of plumbing systems.

1.02 REFERENCES

A. American Concrete Institute (ACI).

B. American Gas Association (AGA).

C. American National Standards Institute (ANSI):
   1. Z21.15 - Manually operated gas valves for appliances, appliance connector valves and hose end valves.

D. American Society of Mechanical Engineers (ASME).
   1. B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
   2. B16.12 - Cast Iron Threaded Drainage Fittings.

E. American Society of Sanitary Engineering (ASSE):
   1. 1070 - Performance Requirements for Water Temperature Limiting Devices.

F. American Water Works Association (AWWA):
   1. C700 - Standard for Cold-Water Meters -- Displacement Type, Bronze Main Case.
   2. C702 - Standard for Cold-Water Meters -- Compound Type.

G. Americans with Disabilities Act (ADA).

H. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
   4. A518 - Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
   5. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   6. A861 - Standard Specification for High-Silicon Iron Pipe and Fittings.
   7. A888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   8. B32 - Standard Specification for Solder Metal.
   9. B88 - Standard Specification for Seamless Copper Water Tube.
   10. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.

11. B823 - Standard Specification for Materials for Copper Base Powder Metallurgy (PM) Structural Parts.
12. C552 - Standard Specification for Cellular Glass Thermal Insulation.
13. C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
14. D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
15. D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride (CPVC) Compounds.
16. D1785 - Standard Specification for Poly(Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
17. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
18. D2467 - Standard Specification for Poly9VINYL Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
19. D2564 - Standard Specification for Solvent Cements for Poly9Vinyl Chloride) (PVC) Plastic Piping Systems.
20. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
21. D2843 - Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.
22. D2863 - Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).
23. D4101 - Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials.
24. F1412 - Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.

I. International Association of Plumbing and Mechanical Officials (IAPMO):
   1. IS 03 - Copper plumbing Tube Pipe and Fittings.

J. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

K. Outside diameter (O.D.)

L. Plumbing and Drainage Institute (PDI):
   1. WH 201 - Water Hammer Arresters Standard.

M. Underwriters Laboratories, Inc. (UL):
   1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

N. United States Environment Protection Agency (EPA): Water Sense.

1.03 DEFINITIONS

A. NEMA: Type 4X enclosure in accordance with NEMA 250.

1.04 REQUIREMENTS

A. Include in plumbing system:
   1. Fixtures.
   2. Drain, vent, and water piping.
   3. Connections and cleanouts.
   4. Fittings and accessories.
   5. Parts and pieces necessary to provide a complete system.
   6. Testing for complete and functional system.

B. Except in typical details, piping is indicated on the Drawings in diagrammatic form. Sizes and locations are indicated on the Drawings; however, not every offset and fitting, nor every structural difficulty that will be encountered in the Work has been indicated.

C. Modify piping alignment indicated on the Drawings as necessary to avoid structural or mechanical obstructions and to clear the work of other trades.

1.05 SUBMITTALS

A. Submit as specified in Section 01300 - Submittal Procedures.

B. Shop drawings, as applicable:
   1. System layout, mechanical, electrical power, and control diagrams.
   2. Nameplate information.
   3. Materials.
   4. Coatings and linings.
   5. Rough-in drawings.
   6. Supports, vibration isolators, and seismic bracing calculations and details.
   7. Primary and ancillary equipment.
   8. Proposed cutting and patching.
   9. Maximum recommended equipment vibration levels and field-testing method.
   10. Copy of factory test results.

C. Operation and maintenance data as specified in Section 01730 - Operation and Maintenance Manuals.

D. Field testing documentation.

E. Warranties.

1.06 QUALITY ASSURANCE

A. Work to be in accordance with the plumbing code specified in Section 01410 - Regulatory Requirements, and in accordance with applicable laws and regulations, including requirements for accessibility, energy, water conservation, and health related requirements for water fountains and coolers.
   1. Where provisions specified in these Specifications or indicated on the Drawings are in conflict with the plumbing code specified in Section 01410 - Regulatory Requirements or laws or regulations, the Code and the laws or regulations take precedence over the specified provisions and design.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

2.02 FIXTURES

A. General:
   1. Fixture fittings and piping which are exposed shall be heavy-duty chrome.
   2. Stops:
      a. Fixtures, except showers, shall have stops at the fixtures' service.
      b. Stops for laboratory equipment, and for other equipment or fixtures for which stops have not been otherwise specified in this Section, shall be chrome-plated straight pattern compression stops or chrome-plated angle pattern compression stops.
   3. Escutcheons to be used for all wall penetrations:
      a. Material: Chrome-plated steel plate.
      b. Manufacturers: One of the following or equal:
         1) Dearborn Brass Co., Model Number 5358.
         2) Keeney Manufacturing Co., Model Number 102 or Number 105.

B. Floor-mounted service sink:
   1. 27 inches by 24 inches Type 304 stainless steel sink; 14 inch deep compartment; 8 inch high backsplash with 45 degree sloped top; 1-1/2 inch wide sloping top channel rims; integral drain board with sink pitched to drain; exposed surfaces polished to a satin finish.
   2. Support on 4, 1-5/8 inch outside diameter tubular legs (LK251 stainless steel); 16 gauge wall thickness; adjustable bullet shaped feet.
   3. Provide single lever faucet that deliver not more than 15 gpm at 60 psig inlet.
   4. Manufacturers: One of the following or equal:
      a. American Standard, Inc.
      b. Crane Co.
      c. Elkay.
      d. Kohler Co.

C. Kitchen sinks:
   1. Self-rimming 18-gauge stainless steel single bowl:
      a. 6 1/2 inches deep, 31 inch by 22 inch.
      b. ADA Compliant
      c. Drop-in installation with quick clip mounting system.
      d. Uniform grain finish.
      e. Flush fittings deck.
      f. Sound dampening.
      g. Offset 3.5 inch drain,
   2. Stainless steel crumb strainer cup.
   3. 1-1/2 inch by 4 inch 20 gauge stainless steel tail piece.
   4. Adjustable cast brass "P" trap with tubing drain to wall; 1-1/2-inch inlet, 1 1/2-inch outlet; ground swivel joint; cleanout plug; slip inlet; faucet supply assembly with 3/8-inch angle valve; wheel handle flexible tube riser; chrome finish.

5. Center mount, single lever faucet: 9-1/2-inch tubular swing spout with aerator, 1.8 gpm maximum flow, brass construction, finished in chrome plate.
6. Manufacturers: One of the following or equal:
    a. Elkay, Lustertone Classic
    b. American Standard, Inc.
    c. Crane Co.
    d. Eljer Ind.
    e. Kohler Co.

D. Toilets, urinals, lavatories, and showers:
1. Provide as indicated on the Drawings.
2. Meet ADA accessibility standards.
3. EPA WaterSense labeled.
4. Flush valve water closets:
    a. Wall mounted vitreous china elongated bowl.
    b. Water-saver type, siphon jet action; 1-1/2-inch top spud; chrome-plated flush valve with vacuum breaker; non-hold-open type handle with flush volume adjustability at 1.28 gallons per flush; 1-inch screwdriver angle stop and flush connection.
    c. White solid plastic seat with open front, stainless steel hinge and check.
    d. Concealed carrier:
        1) Mounting height as required.
    e. Manufacturers: One of the following or equal:
        1) Flush valve water closets:
            a) American Standard, Inc.
            b) Crane Co.
            c) Eljer Ind.
            d) Kohler Co.
        2) Flush valves:
            a) Delany.
            b) Sloan Valve Co.
        3) Carrier:
            a) Josam Co.
            b) Jay R. Smith Manufacturing Co.
            c) Zurn Ind., Inc.
5. Flush type urinals:
    a. Wall-mounted with concealed hanger vitreous china washout bowl.
    b. 3/4-inch top spud, outlet connection threaded 2 inches inside; flush chrome-plated brass valve with vacuum breaker; 0.5 gallons per flush; 3/4-inch screwdriver stop and flush connection; and concealed carrier.
    c. Manufacturers: One of the following or equal:
        1) Urinals:
            a) American Standard, Inc.
            b) Crane Co.
            c) Eljer Ind.
            d) Kohler Co.
        2) Flush valve:
            a) Delany.
            b) Sloan Valve Co.
            c) Watrous.

3) Carrier:
a) Josam Co.
b) Jay R. Smith Manufacturing Co.
c) Zurn Ind., Inc.

6. Lavatories:
a. Wall mounted 20-inch by 18-inch vitreous china bowl with backsplash and front overflow.
b. Concealed arms and concealed wall hanger.
c. 1-inch diameter drilling for soap dispenser and soap depression.
d. 4-inch center inlets; faucet, 4-inch centers; automatic flow control; 1/2-inch male IP connectors; chrome finish, 3/8-inch supply assemblies, 3/8-inch angle valve, loose key handles; escutcheon drain with integral perforated grid, 1-1/4-inch diameter by 4-inch tail piece; adjustable cast brass "P" trap with 1-1/4-inch inlet, 1-1/4-inch outlet, escutcheon and chrome finish.
e. Faucet that delivers not more than 0.5 gpm at 60 psig inlet.
f. Manufacturers: One of the following or equal:
1) Lavatory:
a) American Standard, Inc.
b) Crane Co.
c) Eljer Ind.
d) Kohler Co.
2) Carrier:
a) Josam Co.
b) Jay R. Smith Manufacturing Co.
c) Zurn Ind., Inc.

7. Shower fixtures:
a. Adjustable spray showerhead, showerhead arm, adjustable escutcheon flange; chrome finish; bypass valve with renewable seats, screwdriver stops; 2.0 gpm flow restrictor at 80 psig inlet pressure.
b. Crown handles, 8-inch centers; chrome finish; 1/2-inch female IPS union supplies and 2.0 gpm flow restrictor at 80 psig inlet pressure.
c. Manufacturers: One of the following or equal:
1) American Standard, Inc.
2) Crane Co.
3) Eljer Ind.
4) Kohler Co.

2.03 PLUMBING AND DRAINAGE PRODUCTS

A. Water hammer arresters:
1. Stainless steel shell.
2. Hydro-pneumatic cushion of argon gas.
3. Elastomer bellows, stainless steel adapter, and female threaded plug.
4. Size arresters for each fixture supply branch:
a. Determined in accordance with the PDI Standard PD1-WH201.
5. Manufacturers: One of the following or equal:
a. Jay R. Smith Manufacturing Co., Series 5000.
b. Josam Co. 75000.
c. Zurn Ind., Inc., Series Z-1700.

B. Trap primers:
   1. Mechanical type:
      a. Automatic trap primer valve with distribution unit and air gap.
      b. Manufacturer: One of the following or equal:
         1) Precision Plumbing Products (PPP) Prime Rite.
         2) J.R. Smith Model 2699.
   2. Electronic trap primers:
      a. Provide electronic trap primer and distribution unit where indicated on the Drawings.
      b. Trap primer shall supply a minimum of 2 ounces of water at 20 pounds per square inch gauge at setting of 10 seconds every 24 hours.
      c. Trap primer shall be pre-assembled in a steel cabinet to be surface mounted:
      d. Trap primer inlet shall be 3/4 inch NPT female. Trap primer outlet shall be 1/2 inch compression fitting.
      e. Manifold shall be 3/4 inch Type "L" copper tubing complying with ASTM B88.
      f. Trap primer shall be provided with backflow prevention.
      g. Trap primer shall be 120 volts.
      h. Manufacturers: One of the following or equal:
         1) Precision Plumbing Products PTS-12.
         2) Sioux Chief 695-ES10.
   3. Trap seals:
      a. Provide trap seal on floor drains.
      b. Manufacturer: The following or equal:
         1) Zurn, Z1072 ZSheild.

C. Cleanouts:
   1. Wall-mounted cleanouts for concealed piping:
      a. Cast-iron tapped tee.
      b. Round smooth stainless-steel access cover, and securing screw.
         1) Manufacturers: One of the following or equal:
            a) Josam Co., 58910-19 (Tee & Plug) and 58600 (Access Cover).
            b) Zurn Ind., Z1445-BP.
   2. Floor cleanouts:
      a. Cast-iron ferrule, countersunk plug, gastight and watertight seal.
      b. Adjustable cleanout head extension.
      c. Scoriated nickel-bronze top, and securing screw.
         1) Heavy-duty top suitable for heavy traffic conditions in unfinished floor areas.
      d. Manufacturers: One of the following or equal:
         1) Josam Co., 56670 for finished floors, 55000 for unfinished floors.
         2) Zurn Ind., Inc., ZN-1400 for finished floors, ZN-1400-HD for unfinished floors.
   3. Yard cleanouts in asphalt or ground areas:
      a. As specified for floor cleanouts in unfinished floor areas.

D. Equipment and floor drains:
   1. Adjustable strainer head, floor level grate.
   2. No-hub outlet and nickel bronze top.

3. Manufacturers: One of the following or equal:
    a. Floor drain:
        1) Josam Co., 30000-A, combination drip drain, less clamping collar.
        2) Zurn Ind., Inc., ZN-415 strainer.

E. Hose bib stations:
1. A 3/4-inch hose bib shall be a 3/4-inch single supply wall mounted hose bib station complete as described below and as indicated on the Drawings.
2. Refer to detail for requirements for hose rack.
3. The hose shall be 50 feet of **3/4**-inch commercial/industrial grade rubber hose.
4. The hose nozzle shall be a 7-pattern select-a-spray with vinyl grip. Unit shall include a hold-open clip for continuous spraying, a rust resistant stainless steel spring, and a lifetime leak proof seal.
5. Manufacturers: The follow or equal:
    a. Flexon Pro Series.
    b. Gilmore Group.

2.04 EQUIPMENT

A. General:
1. As specified when applicable in Section 15050 - Common Work Results For Mechanical Equipment.

B. Water heaters:
1. Size and requirements as indicated on the Drawings.
2. Provide with temperature limiting device meeting ASSE 1070.
3. Tankless electric water heaters:
    a. High temperature limit switch with automatic reset.
    b. Compression fittings.
    c. Maximum operating pressure of 150 psig.
    d. Flow switch activated:
        1) Ni Chrome heating coils activate at **0.3** gpm.
    e. Single lavatory:
        1) Manufacturers: One of the following or equal:
            a) Eemax models, as scheduled.
            b) Keltech, similar series.
    f. Emergency shower/eye wash and multiple fixtures:
        1) Manufacturers: One of the following or equal:
            a) Eemax,models as scheduled.
            b) Haws, similar models.
            c) Keltech, similar models.

2.05 DRAIN, WASTE, AND VENT PIPING

A. Cast iron soil pipe:
1. Bell-and-spigot service weight in accordance with ASTM A74.
    a. "No Hub" optional for above ground.
2. Joints underground: positive double seal compression type gaskets in accordance with ASTM C564.

3. Joints aboveground:
    a. American standard taper screw threads, cut clean and made up with Teflon™ tape or an acceptable paste thread compound applied to the male threads only.
    b. Slip joints permitted only in trap seals or on the inlet side of the traps.
        1) Do not use long screws or bushings.
4. Cast iron drainage pattern fittings.
5. Couplings for "No Hub": Stainless steel corrugated shield and clamp assembly over a molded 1-piece neoprene sealing sleeve, in accordance with ASTM A888.
6. Line pipe and fittings inside and coat outside with bituminous coating except as follows:
    a. Outside of piping, provide aboveground piping with uncoated outside where piping is specified to be painted as specified in Section 09960 - High-Performance Coatings.
    b. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

2.06 POTABLE COLD AND HOT WATER PIPING

A. Seamless copper water tube:
1. Type: ASTM B88:
    a. Exposed copper piping or tubing: Type L hard-drawn, rigid.
    b. Copper tubing buried in the ground or in plastic conduit: Type K soft annealed.
2. Fittings: Solder type forged, or wrought copper.
    a. Manufacturers: One of the following or equal:
        1) Crawford Fitting Co., Swagelok.
        2) Hoke, Gyrolok.
        3) Parker.
3. Solder: ASTM B32, Alloy Grade Sb5.
4. Flux: ASTM B813.
5. Dielectric insulating unions or fittings:
    a. Manufacturers: One of the following or equal:
        1) Mueller Co.
        2) Watts Series 3001A.
6. Special thread to tube adapters:
    a. Manufacturers: One of the following or equal:
        1) Crawford Fitting Co., Swagelok.
        2) Hoke, Gyrolok.
        3) Parker.

2.07 LINK TYPE SEALS

A. Characteristics:
1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
2. Links to form a continuous rubber belt around the pipe.
3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.

4. Hardware to be Type 316 stainless steel.
    a. Provide anti-galling lubricant for threads.

B. One of the following or equal:
    1. Link-Seal.
    2. Pipe Linx.

2.08 PIPE INSULATION

A. General:
    1. As specified in Section 01600(01_60_00) - Product Requirements.
    2. Insulation thicknesses: Provide insulation thickness in inches in accordance with the following table. Insulation thickness shown is nominal. Manufacturing tolerance of 15 percent variation is permissible.

B. Insulation, Type 1:
    1. Insulation material: Closed cell elastomeric insulation.
    2. Minimum temperature range: Minus 40 degrees Fahrenheit to plus 220 degrees Fahrenheit.
    3. K factor at 75 degrees Fahrenheit: Not more than 0.27 BTU-inch/hour-square feet-degrees Fahrenheit.
    4. Fire ratings:
        a. Flame spread: 25 or less.
        b. Smoke density: 50 or less for insulation thicknesses up to 1.5 inches.
    5. Joints: Seal with manufacturer's recommended contact adhesive to form continuous water barrier.
    6. Manufacturers: One of the following or equal:
        a. Aeroflex USA Inc., Aerocel® AC.
        b. Armacell®, AP Armaflex.

C. Insulation, Type 2:
    1. Insulation material: Preformed mineral fiberglass insulation made from glass fibers bonded with a thermosetting resin.
        a. In accordance with ASTM C547, Class 1.
        b. Provide with factory installed vapor barrier.
            1) Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type I.
            2) Longitudinal lap seals: Pressure-sensitive, self-sealing longitudinal lap strip with factory applied adhesive.
            3) Circumferential butt seals: 4-inch wide tape or similar properties or 4 inch wide overlap with adhesive seal.
            4) Vapor barrier permeability: 0.02 perms or lower.
            5) Vapor barrier flame spread rating: 25 or less.
    2. Minimum temperature range: Minus 0 degrees Fahrenheit to plus 850 degrees Fahrenheit.
    3. K factor at 75 degrees Fahrenheit: Not more than 0.23 BTU-inch/hour-square feet degrees Fahrenheit.
    4. Maximum moisture absorption, volume percent: 5.
    5. Manufacturers: One of the following or equal:
        a. Owens-Corning , Fiberglas™ FLEXWRAP® ASJ
        b. Johns Manville, Micro-Lok® HP.
        c. Knauf Insulation, Earthwool® Redi-Klad® 1000° Pipe Insulation.

D. Insulation jackets:
   1. Type 1:
      a. Material: Ultraviolet-resistant polyvinyl chloride jacketing, 20 mil minimum thickness.
      b. Fire rating: 25 maximum flame spread, smoke developed 50 or less.
      c. Color: White.
      d. Overlap: 1-inch minimum at joints and fittings.
      e. Joint seal: PVC solvent welded or adhesive as recommended by the manufacturer.
      f. Fittings: Factory made with full thickness insulation.
      g. Manufacturers: One of the following or equal:
         1) Johns Manville, Zeston® 2000 PVC.
         2) Proto Corp., LoSMOKE PVC.
         3) Speedline® Corp., Smoke-Safe™ PVC.

E. Vapor barriers:
   1. Vapor barrier, Type 1:
      a. Material: White Kraft paper bound to aluminum foil in accordance with ASTM C1136, Type 1.
      b. Permeability: 0.02 perms or lower.
      c. Maximum flame spread rating: 25.
      d. Edge seal: Pressure-sensitive tape lap seal.
      e. Circumferential joints: 4-inch wide tape or 4-inch overlap with adhesive seal.
   2. Vapor barrier, Type 2:
      a. Material: Mastic.
      b. Manufacturers: One of the following or equal:
         1) Benjamin Foster, No. 30-76.
         2) Childers Products CP10/11 Vi-Acryl.
         3) Foster Products, 36-10/46-10 Weatherite.
         4) Insul-Coustic, No. I.C.-580.

F. Insulation schedule:

Table 2 - Insulation Schedule

Service Designation[1]	Location[2]	Insulation Type[3]	Jacket Type[3]	Service Temp. °F[4]	Vapor Barrier
Hot Water	Interior or Exterior	1 or 2	Type 1 on Exterior installations, none required on Interior installations	100-200	Install on Type 2 insulation
HVAC Refrigerant	Interior or Exterior	1	1	Below 40	Required

Table 2 - Insulation Schedule					
Service Designation(1)	**Location(2)**	**Insulation Type(3)**	**Jacket Type(3)**	**Service Temp. °F(4)**	**Vapor Barrier**

Notes:
1. Refer to Piping Schedule in Section 15052 - Common Work Results for General Piping for service designations.
2. Insulation jackets are not required for interior installations that are concealed. See definitions for description of concealed locations.
3. Contractor may select from options listed.
4. Unless noted otherwise, use service temperature range provided in this table to establish insulation thickness as required by Table 1.
5. Insulate all piping systems that are heat traced as indicated on the Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

B. As specified in Section 15082 - Piping Insulation.

C. Conceal plumbing piping unless otherwise indicated on the Drawings or specified in the specifications.

D. Furnish and install vents required in drainage piping as part of the plumbing system, in accordance with Laws and Regulations.

E. Use Link Type Seals as indicated on the Drawings.

3.02 INSTALLATION

A. Fixtures:
   1. Rough-in fixtures and accessories in accordance with the dimensions supplied by the manufacturers of the fixtures.
   2. Mount fixtures and accessories without cutting of finish surface.

B. Plumbing and drainage products:
   1. Provide cleanouts of the same size as the size of the waste and drain piping on which cleanouts are installed, up to 4 inches in diameter. Provide cleanouts 4 inches in diameter on waste and drain piping larger than 4 inches diameter.
   2. Provide traps at all fixture and equipment connections to the sanitary drainage system. Install traps as near to the fixtures as possible.
   3. Sizes of equipment drains and of floor drains shall be as indicated on the Drawings.
   4. When indicated on the Drawings, cut holes in heavy-duty floor drain grate for a drainpipe from equipment or other source.

C. Equipment:
   1. As specified when applicable in Section 15050 - Common Work Results For Mechanical Equipment.
   2. Provide piping for drain and overflow connections to drains.

D. Drain, waste, and vent piping:
   1. As specified when applicable in Section 15052 - Common Work Results for General Piping.
   2. Where not specified otherwise, install horizontal piping with a grade of 1/4 inch per foot.
   3. Provide vents, roof drains, and pipes flashed and made watertight at the roof with lead sheet flashings.
      a. Minimum 4-pound lead sheet.
   4. Extend flashing not less than 6 inches up the pipes, and counterflash with standard cast iron or malleable iron recessed roof couplings.
   5. Extend flashing for vents up to the top of the vent and turn down into the pipe.
   6. Extend flashing shields not less than 8 inches from vent and pipe in all directions.

E. Potable cold and hot water piping:
   1. Install copper tubing in accordance with ASTM B828 and IAPMO IS 03.
   2. Install copper tubing in straight runs, supported at intervals close enough to avoid sagging.
   3. Make cuts square with a tubing cutter or with a 32-tooth hacksaw.
      a. Provide a sizing tool to correct distortions.
   4. Ream the inside of the tubing and remove burrs from the outside, holding the end of the tubing downward and preventing chips and fillings from entering the tubing.
   5. Perform flaring with a flare block and yoke type screw feed flaring tool:
      a. After removing the tubing from the flare block, inspect both surfaces of the flare for splits, cracks, or other imperfections.
      b. Where there are imperfections, cut off the imperfect flare, and prepare a new flare.
   6. Insulate piping as specified.

3.03 FIELD QUALITY CONTROL

A. Testing:
   1. Test soil, waste, drain, and vent lines as specified and in accordance with plumbing code as specified in Section 01410 - Regulatory Requirements.
   2. Test water piping with water under a pressure of 100 psig.
      a. As required per code.
   3. Repair and correct defective work disclosed by testing. Repeat testing until defective work is corrected.

3.04 CLEANING AND DISINFECTION

A. Upon completion of installation, clean piping interior of foreign matter and debris.

B. Flush and disinfect potable water piping as specified in Section 01757 - Disinfection.

3.05 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

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SECTION 15430

EMERGENCY EYE/FACE WASH AND SHOWER EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Emergency shower and eyewash.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Z358.1 - Emergency Eyewash and Shower Equipment.

B. American Society of Mechanical Engineers (ASME).

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. National Fire Protection Association (NFPA).

E. Occupational Safety and Health Administration (OSHA).

F. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Provide warranty as specified in Section 01783 - Warranties and Bonds.

1.05 QUALITY ASSURANCE

A. Regulatory requirements:
   1. As applicable, equipment of this Section shall comply with requirements of including ASME, NFPA, OSHA, UL.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver to the job site in manufacturer's original containers.

B. Delivery: After wet operations in building are completed.

C. Storage and protection:
   1. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.
   2. Keep materials dry until ready for use.
   3. Keep packages of material off the ground, under cover, and away from sweating walls and other damp surfaces.
   4. Protect finished surfaces from soiling and damage during handling and installation. Keep covered with a protective covering.

PART 2 PRODUCTS

2.01 EMERGENCY SHOWERS AND EYE/FACE WASHES

A. General design requirements:
   1. Combination unit emergency shower with eye/face wash:
      a. Floor mounted fixture consisting of pipe standard, showerhead assembly, and eyewash assembly.
      b. Provide stanchion and floor flange, with interconnecting piping.
   2. Showerhead flow: 20.0 gallons per minute flow, minimum.
   3. Eye/face wash flow: 3.0 gallons per minute flow, minimum.
   4. Meet or exceed all requirements of ANSI Z358.1.
   5. Provide ANSI compliant identification sign and markings.

B. Shower/eyewash unit with integral controls to alarm the system is in use.
   1. Flow switch:
      a. Construction:
         1) NEMA Type 4.
         2) Brass or Type 316 Stainless Steel.
      b. Type: Magnetic proximity switch.
      c. Alarm Contacts: Double pole, double throw contacts rated at 2.0 Amps at 120VAC configurable for either Normally Open or Normally Closed.
   2. Control panel:
      a. Construction:
         1) NEMA Type 4.
         2) Cast aluminum or steel Box with 3 conduit hubs.
         3) Stainless steel cover plate.
      b. Silence/On - Off switch:
         1) NEMA Type 4.
         2) Maintain position, black, with nameplate.
         3) 1 set of auxiliary contacts.
      c. Power: 0.6 Amps at 120VAC.
   3. Strobe:
      a. Construction:
         1) NEMA Type 4.
         2) 120VAC, AMBER Flashing LED.

4. Horn:
    a. Construction:
    b. NEMA Type 4.
    c. 90dB at 10 feet Audible alarm.

C. Freeze resistant combination unit emergency shower and eye/face wash:
1. Manufacturers: One of the following or equal:
    a. Bradley, Model No. S19-304GAB.
    b. Guardian Equipment, Model No. GFR3100.
    c. HAWS, Model No. 8317CTFP.
2. Pipe standard:
    a. 1-1/4-inch galvanized steel pipe and fittings, wrapped with self-regulating heat cable.
    b. Encase piping and fittings in UV resistant ABS plastic jacket with internal foam insulation; 5 inch diameter floor flange.
3. Shower head:
    a. Material and size: ABS plastic, 10-inch diameter with 20 GPM flow control.
    b. Valve and actuator: Chrome plated brass stay open steel ball valve actuated by rigid stainless steel pull rod.
4. Eye/face wash:
    a. Valve and actuator: Stay open chrome plated brass ball valve with stainless steel ball and stem operated by a stainless steel or epoxy coated aluminum push handle.
    b. Heads: Twin ABS plastic or polypropylene soft-flow eye/face wash type heads, with integral flip top protective dust covers releasing with water pressure.

D. Eye/face wash: Wall mounted (ADA compliant):
1. Manufacturers: One of the following or equal:
    a. Bradley, Model No. S19-220BF.
    b. Guardian Equipment, Model No. GBF1721.
    c. Haws, Model No. 7752WC.
2. Skirt: Stainless steel.
3. Bowl: Stainless steel, 11-1/4 inch diameter.
4. Heads: Chrome-plated brass spray head assembly with eye wash heads and protective spray head covers.
5. Stream control: Integral flow control for steady flow under varying water-supply conditions.
    a. Other features: Stay-open ball valve manually operated by stainless steel push flag handle. Provide 1/2-inch IPS supply, 1-1/4-inch IPS drain, and 1-1/2-inch satin chrome-plated trap.

E. Safety shower and eye/face wash tepid water mixing valves:
1. Manufacturers: One of the following or equal:
    a. Bradley, Model No. S19-2250.
    b. Guardian Equipment, Model No. G3800 Series.
    c. Haws, Model No. 9201 Series.
2. General requirements:
    a. Provide 1 mixing valve for each safety unit or group of safety units mounted within 100 feet of each other.

3. Tepid water system to provide a minimum of 20 gallons per minute for shower and 3 gallons per minute for eye/face wash of water for a period of at least 15 minutes at a delivery temperature of 80 to 85 degrees Fahrenheit.

F. Safety shower tester:
   1. Manufacturers: One of the following or equal:
      a. Bradley, Model No. S19-330ST.
      b. Guardian Equipment, Model No. AP250-005.
      c. Haws, Model No. 9010 with No. 9009.
   2. Kit includes:
      a. Minimum 5 gallon plastic bucket.
      b. 7 foot long watertight 12-gallon translucent vinyl plastic bag for attaching over drench showerhead.
         1) Bag shall have drawstring at top and be hemmed at bottom.
      c. Testing record card.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturers' recommendations.

B. Install products in accordance with code requirements and ANSI Z358.1.

C. Plumbing and mechanical work as specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Electrical connections and distribution as specified in Section 16200 - Wires, Conductors and Cable - 600V and Below and Section 17600 - Distributed Control System.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Functional testing:
   1. Shower/eyewash unit with integral controls:
      a. Test witnessing: Witnessed.
      b. Electrical Instrumentation and Controls:
         1) Test witnessing: Witnessed.
         2) Conduct testing as specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

END OF SECTION

SECTION 15735

POSITIVE PRESSURIZATION EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Positive pressurization unit.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):
   1. 210 - Laboratory Methods for Testing Fans for Certified Aerodynamic Performance Rating.
   2. 211 - Certified Ratings Program – Product Rating Manual for Fan Air Performance.
   3. 300 – Reverberant Room Method for Sound Testing of Fans.
   4. 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
   1. 430 – Performance Rating of Central Station Air-handling Unit Supply Fans.

C. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE):
   1. Standard 52.2 - Methods of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   2. Standard 68 - Laboratory Method of Testing to Determine the Sound Power in a Duct.

D. National Electrical Manufacturers Association (NEMA).

E. National Fire Protection Association (NFPA):
   1. 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems.

F. Underwriters' Laboratories, Inc. (UL):
   1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
   2. 508 - Standard for Industrial Control Equipment.
   3. 508A - Standard for Industrial Control Panels.

1.03 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Shop drawings:
   1. System layout, mechanical, electrical power, and control diagrams.
   2. Nameplate information.
   3. Materials.
   4. Supports, vibration isolators, and seismic bracing calculations and details.

5. Primary and ancillary equipment.
6. Proposed cutting and patching, when required.
7. Maximum recommended equipment vibration levels and field-testing method.
8. Noise levels in 8 octave bands showing compliance with specified levels.
9. Bearing life.
10. Fan performance curves showing specified operating condition.
11. Copy of factory test results.

C. Furnish motor product data.

D. Operation and maintenance data as specified in Section 01730 – Operation and Maintenance Manuals.

E. Warranties.

1.04 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
   1. Provide all components and equipment with UL 508 listing.
   2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling.

B. Qualification of PPU manufacturer: Manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce products of quality specified with a minimum 5 years satisfactory performance record.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver units in 1 piece, factory assembled, piped, internally wired, and tested.

B. Protect equipment from dust and atmospheric exposure:
   1. Provide temporary closures for equipment openings designed for airflow.

1.06 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Special warranties: From the date of acceptance of the project or the date of beneficial use.
   1. All components: 1-year warranty.

1.07 MAINTENANCE

A. Extra materials:
   1. Extra materials: Provide 2 extra (3 total) sets of filters per unit installed.

B. Special tools: Deliver 1 set of special tools needed to assemble and disassemble the components of the PPU requiring regular maintenance.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Design requirements:
   1. Provide fans that have sharply rising pressure characteristics which extend throughout the operating range and continue to rise beyond the efficiency peak.
   2. Provide fans that peak as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.
   3. When scheduled, provide guided vibration isolator for fans, so that not more than 10 percent of the vibration amplitude of the fan and motor is transmitted to the supporting structure.
   4. Design fan inner scroll and air stream surfaces to maintain smoothness for entire fan service life.
   5. Seismic supports: Seismic design criteria as specified in Section 01612 - Seismic Design Criteria.
   6. Wind supports for exterior units: Wind design criteria as specified in Section 01614 - Wind Design Criteria.
   7. Applicable portions as specified in Section 15050 - Common Work Results for Mechanical Equipment.
   8. Insulation and adhesives: In accordance with NFPA 90A requirements for flame spread and smoke generation.
   9. Belt drive systems: Adjustable for minimum within 5 percent speed change, rated for 1.5 times maximum horsepower motor available for the scheduled fan size or model.
   10. Finishes: When not specified with fan type, coat ferrous metals as specified in Section 09960 - High-Performance Coatings.
   11. Unit fabrication: In accordance with AHRI 430.

B. Performance requirements:
   1. As specified and as listed on the Positive Pressurization Unit Schedule at the end of this Section or as indicated on the Drawings.
   2. Environmental conditions: As specified in 01610 - Project Design Criteria.
   3. Fan performance: Rated and licensed to bear the AMCA label in accordance with AMCA 210 and AMCA 211.
   4. Total sound power levels in the 8 octave band range as measured in accordance with ASHRAE Standard 68, AMCA 301, or AMCA 300 as appropriate for each fan: Not to exceed the lesser of the following or the Sones levels on the Fan Schedule.

Sound Power Level, decibel levels referenced to 10-12 watts								
Frequency, Hz	63	125	250	500	1,000	2,000	4,000	8,000
General	100	98	94	88	84	84	78	75

   5. Bearings: As specified in the individual component requirements.

2.02 POSITIVE PRESSURIZATION UNIT (PPU)

A. Manufacturers: One of the following or equal:
   1. Circul-Aire, division of P.M. Wright Limited.
   2. Purafil.
   3. American Air Filter.

B. General:
   1. Units shall be factory assembled with cabinet, fan, filters, dampers, access sections with hinged access doors, motor, motor base, drive, drive guard and vibration isolators.
      a. Units not mounted on vibration isolators shall have all rotating components internally isolated from the main unit with vibration isolators.
   2. All transition sections and filler pieces required between sections are to be provided as part of the unit.
   3. As specified in Section 01600 - Product Requirements and 15050 - Common Work Results for Mechanical Equipment.
   4. Provide nameplate to each panel as indicated on the Drawings:
      a. Provide a nameplate with the following markings that is plainly visible after installation:
         1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
         2) Supply voltage, phase, frequency, and full-load current.
         3) Power source or circuit ID.
         4) Short-circuit current rating of the panel based on one of the following:
            a) Short-circuit current rating of a listed and labeled assembly.
            b) Short-circuit current rating established utilizing an approved method.
   5. Internal wiring to be enclosed inside weatherproof flexible UL listed conduit.
   6. Automatic freeze protection system when unit is installed outside.
   7. Filters:
      a. Type, thickness, and efficiency as specified in PPU schedule.
      b. Filter frame supports:
         1) 18 gauge Aluminum with Aluminum casing.
         2) 18 gauge Type 304 stainless steel with stainless steel casing.
      c. Slide out frame with hinged access door.

C. Housing:
   1. Housing shall be constructed of 18 gauge steel and consist of 1.5-inch deep double wall panels filled with 2.0 pounds per cubic unit feet dense insulation. All interior seams shall be sealed to prevent leakage.
   2. All filter tracks shall contain a 1-inch by 0.125-inch nylon pile with plastic fin to prevent air bypass.
   3. Access doors shall be 1.5-inch deep double wall filled with 2.0 pounds per cubic unit feet insulation. All doors shall have positive locking latches to secure and compress the PVC closed cell gasket to prevent leakage.
   4. Fan section, intake, and discharge plenums shall be lined with flexible polyester urethane foam acoustic insulation that is non-allergenic and inert, meeting flammability classification UL 94.
   5. All metal surfaces shall be coated with a lift resistant alkyd primer, followed by a 2 component polyurethane coating with a light grey low-sheen finish.

6. Openings shall be sized for face velocity of 500 feet per minute maximum at indicated airflow rates on schedule.
7. Grilles shall be provided for openings as indicated on the Drawings. Grilles shall be double-deflection, adjustable type.
8. Provide the inlet (return) opening with an integral manual balance damper with an external position-indicating handle with locking quadrant. Dampers shall be opposed blade type.
9. Provide a duct collar for field installation of the outside air duct as indicated on the Drawings. Provide OA inlet hood for OA opening as indicated on the Drawings.

D. Fan section:
1. Fans shall be backward inclined, airfoil impeller molded from glass reinforced polyamide.
2. Drives shall be adjustable V-belt type, with motor mounted on an adjustable slide base.
3. Backwardly curved wheels shall be air foil type.
4. All fans shall be statically balanced before shipment.
5. Fans shall be AMCA rated for sound and air performance.

E. Filters:
1. See schedule for filter types by unit.
2. Unit shall be constructed with a contaminant control system consisting of multiple stages of filtration. Refer to schedule for filter types by unit and stage.
3. Pre-filter requirements:
   a. Pre-filters shall be non-woven, pleated, reinforced cotton and synthetic fabric disposable type, framed filters, thickness as scheduled.
   b. Media shall be supported and retained with aluminum or stainless steel track securely attached to housing.
   c. Filter pressure drop for clean filters at 300 feet per minute face velocity shall be 0.15-inch w.g. for 2-inch thick filters.
   d. Filter shall have 30 to 35 percent efficiency on ASHRAE Standard 52.2. Filter type shall be equal to Farr 30/30 Disposable Filters.
4. First, second, third media stage:
   a. Intermediate stage shall be chemical filter media, consisting of activated carbon and activated alumina impregnated with potassium permanganate.
   b. Refer to the schedules for specific chemical filter requirements including required range of contaminant removal.
   c. All filter media shall be supported and retained with extruded aluminum or stainless steel track securely attached to the housing.
   d. Filters shall be capable of handling airstreams at the expected temperature, humidity, and air contaminant ranges indicated in the schedules.
   e. Media shall be disposable in standard dumpsters. Media shall be replaced either by discarding media housing or recycling by emptying spent media and refilling with new media.
5. After-filter requirements:
   a. Final filter where specified is to remove air borne media from the exit air stream.
   b. Rigid filters shall have permanent aluminum or stainless steel holding frame and replaceable type rigid filter cartridge with minimum efficiency of 90 to 95 percent on ASHRAE Standard 52.2.

c. Filter pressure drop for clean filters at 500 feet per minute face velocity not to exceed 0.65-inch w.g.
    1) Filters shall be UL:
        a) Manufacturers One of the following or equal:
            (1) American Filter Co.:
                (a) Type Varicel .Farr Co.
                (b) Type Riga-Flo 200.
            (2) Cambridge:
                (a) Type Aeropac.

F. Gauges:
1. Provide differential pressure gauges as specified in 15936 - Instrumentation and Control Devices for HVAC.
2. Provide a differential pressure gauge across the pre-filter, after filters, final filters, and fans.
    a. Where more than 1 filter is used in series, each filter shall be provided with a separate gauge.
    b. Pressure range of gauges shall be 3 times the clean pressure loss of the filters provided.

G. Switches:
1. Provide differential pressure switches as specified in 15936 - Instrumentation and Control Devices for HVAC.
2. Provide a differential pressure switch for the pre-filter, after filters, final filters, and fans.
    a. Where more than 1 filter is used in series, each filter shall be provided with a separate switch.
3. Wire the differential pressure switches to provide a signal dirty filter alarm.

H. Media sampling:
1. Manufacturer shall include sampling services of chemical media in cost of purchased media without additional cost to Owner. Manufacturer shall support media sampling services through a licensed and trained factory representative.
2. Upon testing of media at manufacturer's facility, manufacturer shall furnish an analysis report to Owner indicating spent level of media and estimated remaining life.

2.03 ACCESSORIES

A. Flexible duct connectors: As specified in 15812 - Metal Ducts and 15814 - Fiberglass Reinforced Plastic Ducts.

B. Dampers and grilles: Provide manufacturers supply and return deflection grilles with integral manual damper.

2.04 SOURCE QUALITY CONTROL

A. Completely factory test each unit in operating modes of filtration prior to shipping the unit. Tests shall comply with relevant codes and standards applicable to unit design.

2.05 CONTROLS

A. General:
   1. Provide system controls for a complete functioning system that operates as specified in 15936 - Instrumentation and Control Devices for HVAC.

B. Motor control:
   1. Provide variable speed motor control by one of the two following methods:
      a. Variable Frequency Drive.
      b. Electronically commutated motor.
   2. Provide external speed adjustment of the fan.
   3. PPU shall accept a single 480 VAC 3 phase power feed.
   4. Provide main power disconnect switch.
   5. Mount motor controller and main power disconnect switch in NEMA 4.

C. Motor characteristics as scheduled in PPU schedule.

D. Remote monitoring and control:
   1. Provide dry relay contact outputs for the following:
      a. Dirty filter discrete signal (i.e., high differential pressure).
      b. Fan running signal.
      c. Common fail.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and verify that Work is in condition to receive installation specified in this Section.
   1. Take measurements and verify dimensions to ascertain fit of installation.
   2. Ascertain structural sufficiency to support installation.
   3. Ascertain that supports and openings are correctly located; otherwise cut new openings where required.
      a. Submit details of proposed cutting and patching.
   4. Confirm specified controls are compatible with specified equipment.

B. Examine and verify structural details and sections indicated on the Drawings, ascertain adequacy, and determine conflicts in dimensions and clearances.

3.02 PREPARATION

A. Before installation, remove dust and debris from equipment and ducts.

B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.03 INSTALLATION

A. Observe applicable installation requirements as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Anchoring and support:
   1. Provide anchoring and support designed in accordance with current engineering practice for equipment and appurtenances by attaching or connecting to supporting members or by providing other supports.

C. Adjust alignment of ducts where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

D. Install and wire positive pressurization unit, and controls in accordance with manufacturer's recommendations.

E. Provide flexible duct and flexible piping connections at connections to positive pressurization unit.

F. Upon completion of installation, clean duct, and debris from ductwork, and equipment.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning, 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Source Testing.
      b. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      a. Installation: 1 trip, 1 day minimum.
      b. Functional Testing: 1 trips, 1 day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 1 hours per session, 2 sessions.
   4. Process operational period.
      a. As required by Owner or Contractor.

C. Source testing:
   1. Test as specified in Section 15958 - Mechanical Equipment Testing.
   2. Equipment:
      a. Test witnessing: Not witnessed.
      b. Conduct Level 1 General Equipment Performance Test.
      c. Conduct Level 1 Vibration Test.
      d. Conduct Level 1 Noise Test.
      e. Each unit shall be factory tested including control functions and economizer operation prior to shipment.
   3. Electrical Instrumentation and Controls:
      a. Test witnessing: Not witnessed.
      b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

D. Functional testing:
   1. Equipment:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test.
      c. Conduct Level 2 Vibration Test.
      d. Conduct Level 2 Noise Test.
      e. Test equipment and installation to verify tightness, operation, and positive pressurization unit vibration is within manufacturer's submitted maximum.
      f. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.
   2. Electrical Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Conduct testing as specified in Section 17100 - Process Instrumentation and Control Systems.

3.05 SCHEDULES

A. Indicated on the Drawings.

END OF SECTION

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SECTION 15740

HEAT PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Heat pump units

1.02 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
   1. 210-240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
   2. 270 - Sound Rating of Outdoor Unitary Equipment.
   3. 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

B. Air Movement and Control Association International, Inc. (AMCA):
   1. 210 - Laboratory Methods for Testing Fans for Certified Aerodynamic Performance Rating.

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   1. Standard 15 - Safety Standard for Refrigeration Systems.
   2. Standard 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   3. Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.

D. American National Standards Institute (ANSI):
   1. Z21.47 - Gas Fired Central Furnaces (except Direct Vent Central Furnaces) with Addenda.

E. Federal Specification (FS):
   1. Standard 141 - Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing.

F. National Electrical Code (NEC).

G. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

H. National Fire Protection Association (NFPA):
   1. 54 - National Fuel Gas Code.
   2. 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

I. National Roofing Contractors Association (NRCA).

J. Underwriters' Laboratories, Inc. (UL).
   1. 900 – Standard for Air Filter Units.

1.03 DEFINITIONS

A. NEMA: Type 3R enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Shop drawings:
   1. System layout, mechanical, electrical power, and control diagrams.
   2. Nameplate information.
   3. Materials.
   4. Supports, vibration isolators, and seismic bracing calculations and details.
   5. Primary and ancillary equipment.
   6. Proposed cutting and patching, when required.
   7. Maximum recommended equipment vibration levels and field-testing method.
   8. Sound power level in each of 8 octave bands and overall Sones.
   9. Bearing life.
   10. Fan performance curves showing specified operating condition.
   11. Copy of factory test results.

C. Operation and maintenance data as specified in Section 01730 - Operation and Maintenance Manuals.

D. Warranties.

E. Provide required commissioning submittals as specified in Section 01756 - Commissioning.

1.05 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels.

B. Qualification of manufacturer: Manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce products of quality specified with a minimum 5 years satisfactory performance record.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver units in 1 piece (or modular, if required), factory assembled, piped, internally wired, and factory tested.

B. Protect equipment from dust and atmospheric exposure as recommended by the unit manufacturer.
   1. Provide temporary closures for equipment openings designed for airflow.

1.07 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.

B. Special warranties:
   1. Refrigerant compressors and closed or sealed refrigerant systems warranty duration: Provide 5-year warranty.
   2. Electric heaters (if supplied) warranty duration: Provide 5-year warranty.
   3. Evaporator and condensing coils warranty duration: Provide 5-year warranty.

1.08 MAINTENANCE

A. Extra materials: Provide 2 extra (3 total) sets of filters per unit installed.

B. Provide 1 set of sheaves and belts for change-out, if required, for final balance per unit installed.

C. After final balance, provide 1 extra set of belts for each unit installed.

D. Special tools: Deliver 1 set of special tools needed to assemble and disassemble the components of the unit requiring regular maintenance.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements and 15050 - Common Work Results for Mechanical Equipment.

B. Inclusion of a specific manufacturer's name in the Specifications does not mean that the specific manufacturer's standard product will be acceptable. Specified manufacturer's or other manufacturer's standard product shall be modified as required to meet the Specifications.

C. All supplied components of the unit shall be furnished and fully integrated by the unit system supplier, having unit responsibility:
   1. Furnish and install all piping, valves, dampers, sensors and wiring within the unit package.
   2. Provide a unit mounted control panel prewired on the unit to all dampers and sensors within the unit.

D. Motors:
   1. Totally enclosed.
   2. Voltage and number of phases as scheduled.
   3. Compressor motors:
      a. Cooled by refrigerant gas passing through windings.
      b. Provided with line break thermal and current overload protection.
   4. Fan and blower motors:
      a. Permanently lubricated ball bearings.
      b. Integral automatic reset thermal overload protection.
   5. Other requirements as specified.

E. Electrical:
   1. Provide a single conduit connection in the unit for both power and control wiring.

2.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Provide fans that have sharply rising pressure characteristics which extend throughout the operating range and continue to rise beyond the efficiency peak.
   2. Provide fans that peak as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.
   3. When scheduled, provide guided vibration isolator for fans, so that not more than 10 percent of the vibration amplitude of the fan and motor is transmitted to the supporting structure.
   4. Design fan inner scroll and air stream surfaces to maintain smoothness for entire fan service life.
   5. Seismic supports: Design supports to comply with the criteria specified in Section 01612 - Seismic Design Criteria.
   6. Wind supports: Design supports to comply with the criteria specified in Section 01614 - Wind Design Criteria.
   7. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
   8. Roof curbs: Designed in accordance with NRCA Standards.
   9. Gas, water piping, drains, and venting: In accordance with building code, mechanical code, and plumbing code as specified in Section 01410 - Regulatory Requirements and in accordance with applicable codes.
   10. Fans supplied with heat pump units: Rated in accordance with AMCA 210.
   11. Unit heat pumps: Rated in accordance with AHRI Standards 210-240 or 340/360 and AHRI 270. Conform to the latest version of ASHRAE 15.
   12. Unit heat pumps with auxiliary heating options: Certified in accordance with ANSI Z21.47.
   13. Insulation and adhesives: In accordance with NFPA 90A requirements for flame spread and smoke generation.
   14. Refrigerant: HCFC R-410A.
   15. Finishes: When not specified with fan type, coat ferrous metals as specified in Section 09960 - High-Performance Coatings.

B. Performance requirements:
   1. Performance requirements as specified and as scheduled on the Heat Pump Schedule indicated on the Drawings.
   2. Outdoor noise levels: Outdoor noise levels in the 8 octave band ranges, as measured in accordance with AHRI Standard 270 for unit heat pumps and split system heat pumps shall not exceed the following:

OCTAVE BANDS								
Unit Nominal Capacity (Tons)	**63**	**125**	**250**	**500**	**1,000**	**2,000**	**4,000**	**8,000**
0 to 5	64	70	71	74	74	71	67	67
6	79	85	78	74	71	73	66	59
7-1/2 to 10	64	70	73	79	82	78	74	67
12 and larger	84	88	84	83	84	78	72	68

3. Units shall be capable of starting and running from 45 to 125 degrees Fahrenheit ambient outdoor air temperature and exceeding the maximum load criteria of AHRI Standard 210-240 or 340/360.
4. Capable of starting and providing heating at or above 0 degrees Fahrenheit outdoor ambient air temperature.
5. Minimum cooling and heating capacities, energy efficiency ratios (EER), and coefficient of performance (COP), as rated in accordance with AHRI 210-240 or 340/360 and 270, unless scheduled otherwise:
6. Units with heating capabilities: Meet or exceed the following efficiencies:
   a. Annual fuel utilization efficiency: 80 percent.
   b. Steady state efficiency: 80 percent.
7. Unit air flows for cooling: A minimum of 300 cubic feet per minute per ton but not exceeding 500 cubic feet per minute per ton of cooling unless scheduled otherwise.
8. Filter:
   a. Media: UL 900 listed, Class I or Class II, approved by local authorities.
   b. Efficiency: 45 to 50 percent dust spot efficiency when rated per ASHRAE Test Standard 52.2.
   c. Face velocity: Per manufacturer recommendation.

2.03 SPLIT SYSTEM HEAT PUMP UNITS

A. Manufacturers: One of the following or equal:
   1. Trane:
      a. Heat Pump, Odyssey TWA Series.
      b. Indoor air handling unit:
         1) TEM Series, or TWE Series, as scheduled.
   2. Carrier:
      a. Heat Pump, Similar Series.
      b. Indoor handling unit, Similar Series.
   3. York:
      a. Heat Pump Similar Series.
      b. **I**ndoor air handling unit, Similar Series.

B. Refrigerant components: Refrigerant circuit including:
   1. Accumulator and filter/drier.
   2. Compressor.
   3. Thermostatic expansion valve.
   4. Gauge ports.
   5. Flow control valves.
   6. Circuit feed system.
   7. Strainer.
   8. Reversing valve.
   9. Service gauge connections with gauges on suction, discharge, and liquid lines to charge, evacuate and contain refrigerant.
   10. Insulate refrigerant piping as specified in Section 15082 - Piping Insulation.

C. Compressors:
   1. Fully hermetically sealed, high efficiency, reciprocating or scroll type, with internal and external vibration isolation.
   2. Equipped with high-pressure relief.
   3. Equipped with crankcase heater.

D. Condenser fan:
   1. Propeller type, direct drive, aluminum blades, dynamically balanced, and vertical discharge.
   2. Permanently sealed ball bearings and permanently lubricated.

E. Heat pump coil:
   1. Seamless copper tubes with mechanically bonded aluminum plate fins.
   2. Heat pump coil, internal piping, and appurtenances: Factory applied phenol-formaldehyde thermosetting resinous coating.

F. Heat pump unit casing:
   1. Manufactured of minimum 22-gauge galvanized steel, bonderized, corrosion protected, and exterior coated with a baked enamel finish interior primer coated. Coating shall withstand FS Test Method Standard 141 (Method 6061) 500-hour salt spray test.
   2. Weatherproof design, reinforced, and braced for maximum rigidity.
   3. Provide gasketed removable panels or access doors to service equipment components and connections.
   4. Provide with:
      a. Non-corrosive drain pan in accordance with ASHRAE Standard 62.1.
      b. Minimum 3/4-inch horizontal drain connection.
      c. Knockouts for utility and control connections.
      d. Minimum 14-gauge steel roll formed base rail with lifting holes; provide support feet for roof mounting on units under 6 tons size.

G. Controls and equipment safety features:
   1. Provide unit controls for a complete and properly functioning system. Provide, as a minimum, the following:
      a. Condenser fan controls.
      b. Evaporator fan controls with time delay after compressor shutdown.
      c. Motor contactors.
      d. 24-volt or 120-volt control circuit as scheduled; if 24-volt scheduled, provide control power transformer.
      e. Manually reset circuit breakers.
      f. 5-minute compressor cycle delay.
      g. Check filter switch suitable for field connection remote alarm.
      h. 2-stage heating and cooling.
      i. Outdoor coil defrost system controls.
      j. Heater controls: When auxiliary heat is scheduled, provide heat package controls to activate auxiliary heat when mechanical heating is locked out.
      k. Provide with low ambient cooling option.
   2. Equipment safety features, include:
      a. High-pressure switch.
      b. Compressor over-temperature and overcurrent.
      c. Loss of charge/low pressure switch.
      d. Freeze thermostat on evaporator.
      e. Lock out protection.
      f. When auxiliary electric heater is specified:
         1) Heat limiters for primary and secondary overcurrent and thermal protection.
            a) Automatic reset switches.
            b) Branch circuit protection.

3. Provide dry-contacts for the following status and alarms:
    a. Failed.
    b. Running.
    c. Dirty Filter.
4. Provide an input connection for a smoke alarm shutdown.
5. Interface to building HVAC controls:
    a. Provide contacts and signals to operate unit with the HVAC control system as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

H. Electrical:
1. Provide 15-amp, 120-volt, single phase, ground fault interrupter convenience outlet at condenser unit; provide factory installed transformer, and independent fuse or breaker protection for outlet.
2. Provide power disconnect switch at each piece of unit; mount disconnect in NEMA Type 3R enclosure if exterior to unit.

I. Indoor air handling unit:
1. Indoor air section compartment: Insulated with minimum 1/2-inch thick, permanent, fireproof, odorless glass fiber material, and coated on the air side.
2. Fan:
    a. Belt driven, forward curved, double inlet, centrifugal type, steel with corrosion resistant finish, statically and dynamically balanced.
    b. Permanently sealed ball bearings and permanently lubricated.
    c. Adjustable pitch motor pulley.
    d. Where the condenser fan is 7.5 horsepower or larger, provide a variable speed or 2 speed fan.
3. Provide with ducted discharge; orientation as scheduled or as indicated on the Drawings. Provide flexible duct connector where ducts connect to units.
4. Provide with direct expansion coil aluminum drip pan and polyvinyl chloride drainpipe.
5. Filter section:
    a. Provide filter with at least a MERV 13 rating.
    b. Provide with 2-inch filters accessible through front of unit.
    c. Provide with expanded metal return air grill to cover filter section.
    d. Low velocity 2-inch thick pleated filters of commercially available sizes.
    e. Filter face velocity: Per manufactures recommendations.
    f. All filters for any 1 unit shall be the same size.
    g. Filter:
        1) Manufacturers: The following or equal:
            a) American Air Filter.
6. Provide sub-base for floor mounting with room for condensate drain; when scheduled provide outside air connection and economizer.
7. Provide manufactured fabricated equipment stand when scheduled.
8. Evaporator coil:
    a. Seamless copper tubes with mechanically bonded aluminum plate fins.
    b. Evaporator coils, internal piping, and appurtenances: Factory applied phenol-formaldehyde thermosetting resinous coating.
9. All components factory painted with optional coating suitable for corrosive environments.

2.04 MINI-SPLIT SYSTEM HEAT PUMPS

A. Manufacturers: One of the following or equal:
   1. Mitsubishi, Series PUZ; when indoor air handling unit scheduled.
      a. Series:
         1) PKA (wall mounted).
   2. Samsung, similar series.
   3. Daikin, similar series.
   4. Trane, similar series.

B. Compressors:
   1. Fully hermetically-sealed, high-efficiency, reciprocating or rotary or scroll-type, with rubber grommet vibration isolation.

C. Fans:
   1. Indoor air fan:
      a. Wall Mounted Type and Ducted Ceiling Suspended:
         1) Direct driven with capacitor start motor; double inlet, forward curve sirocco fan, steel with corrosion resistant finish, statically and dynamically balanced.
      b. Bearings: permanently sealed ball bearing type and permanently lubricated.
   2. Outdoor condenser fan:
      a. Propeller type, direct drive, aluminum blades, dynamically balanced.
      b. Bearings: Permanently sealed ball bearing type and permanently lubricated.

D. Coils:
   1. Evaporator and condenser coils: seamless copper tubes with mechanically bonded aluminum plate fins.
   2. Provide corrosion resistant finish, suitable for marine environment.

E. Refrigerant components: Refrigerant circuit including:
   1. Accumulator and filter/drier.
   2. Expansion device.
   3. Reversing valve.
   4. Flow control valves.
   5. Service and gauge connections on compressor suction and discharge, and liquid lines to charge, evacuate, and contain refrigerant.

F. Controls and equipment safety features:
   1. Provide system controls for a complete functioning system:
      a. High and low evaporator fan speed control for cooling and heating modes.
      b. Fan only operation.
      c. Ventilation control; open (exhaust) or closed.
      d. Space temperature condition setting.
      e. Vapor bellows thermostat to cycle unit to maintain space condition.
   2. Equipment safety features:
      a. Thermostatic base pan drain to prevent freeze up of the fan in collected condensate.
   3. Provide with a low ambient cooling option.

G. Unit casing:
   1. Wall Mounted Type:
      a. Slide-out design unit casing manufactured of high strength molded plastic with smooth finish and outdoor casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, polyester powder coating for corrosion protection.
   2. Weatherproof design, reinforced and braced for maximum rigidity.
   3. Provided with:
      a. Filter rack for filters accessible through the front or top of the unit, as required per the drawings.
      b. Non-corrosive drain pan in accordance with ASHRAE Standard 62.1.
      c. Horizontal drain connection.
      d. Provide mini condensate pump suitable to be powered from indoor/outdoor unit.
      e. Knockouts for power connections.
      f. Provide wall sleeve of galvanized steel coated similar to unit casing.

2.05 ACCESSORIES

A. Curb assemblies:
   1. Provide where called for on the Heat Pump and/or as indicated on the Drawings.
   2. Factory fabricated of aluminum with wood nailer strip and gaskets.
   3. Capable of supporting entire unit weight.
   4. Suitable for installing and connecting ductwork to curb.
   5. In accordance with NRCA Standards.
   6. Height:
      a. Shall extend a minimum of 12 inches above top of built up roofing, but shall be no more than 15 inches high for Packaged Heat Pump Units.
      b. Shall extend a minimum of 8 inches above top of built up roofing, but shall be no less than 14 inches high for Split System Heat Pump Units outdoor condensing unit.
   7. Flashing in accordance with NRCA Standards.

B. Economizer, when scheduled provide:
   1. Integrated type capable of compressor operation while modulating to utilize up to 100 percent outdoor air for cooling when outdoor air and humidity are at set acceptable levels.
   2. Including:
      a. Differential bulb enthalpy control.
      b. Damper drive motor.
      c. Gravity relief damper.
      d. Low leakage dampers, not to exceed 3 percent leakage at 1-inch static pressure.
   3. Differential enthalpy sensor for economizer control.

C. Sensors: As specified in Section 15936 – Instrumentation and Control Devices for HVAC.

D. Provide flue hood protector assembly to protect from the hot sides of the gas flue hood.

E. Provide hail guard to protect against damage from hail and other flying debris.

F. Provide NO_x reduction kit to reduce NO_x emission levels to no more than 40 nanograms per joule.

G. Provide dirty filter switch with contacts for field installed remote light or alarm.

H. Provide coil guard grill to protect condenser coil from penetration by large objects.

I. Provide condensate drain per mechanical code as specified in Section 01410 - Regulatory Requirements.

J. Flexible duct connectors: As specified in Section 15820 - Ductwork Accessories.

PART 3 EXECUTION

3.01 GENERAL

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners, as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Prior to installation, protect equipment from dust and atmospheric exposure as recommended by the unit manufacturer.
   1. Provide temporary closures for equipment openings designed for airflow.

C. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

D. Examine and verify details and sections indicated on the Drawings, ascertain adequacy, and determine conflicts in dimensions and clearances.
   1. Take measurements and verify dimensions to ascertain fit of installation.
   2. Ascertain structural sufficiency to support installation.
   3. Ascertain that supports and openings are correctly located; otherwise cut new openings where required.
      a. Submit details of proposed cutting and patching.
   4. Confirm specified thermostat or other controls are compatible with specified equipment.

3.02 INSTALLATION

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Before installation, remove dust and debris from equipment and ducts.

B. Anchoring and support:
   1. Provide anchoring and support designed in accordance with current engineering practice for equipment and appurtenances by attaching or connecting to supporting members or by providing other supports.

C. Adjust alignment of ducts where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

D. Install and wire unit air conditioners, controls, and thermostats in accordance with manufacturer's recommendations.
   1. Provide local disconnect switches.

E. Provide flexible duct and flexible piping connections at connections to unit air conditioners.

F. Install roof curb and unit as recommended by unit manufacturer.

G. Install NRCA approved flashing and counterflashing.

H. Provide venting in accordance with building code, mechanical code, and plumbing code as specified in Section 01410 - Regulatory Requirements and in accordance with NFPA 54.

I. Upon completion of installation, clean duct, and debris from ductwork, and equipment.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Source Testing.
      b. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      a. Installation: 1 trip, 1 day minimum.
      b. Functional Testing: 1 trips, 1 day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 1 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing:
   1. Test as specified in Section 15958 - Mechanical Equipment Testing.
   2. Equipment:
      a. Test witnessing: Not witnessed.
      b. Conduct Level 1 General Equipment Performance Test.
      c. Conduct Level 1 Vibration Test.
      d. Conduct Level 1 Noise Test.
      e. Factory test in cooling and heating modes including economizer operation. Evacuate coils and refrigerant system for 30 minutes prior to final charging of unit before shipment.
   3. Electrical Instrumentation and Controls:
      a. Test witnessing: Not witnessed.
      b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

D. Functional testing:
   1. Equipment:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test.
      c. Conduct Level 2 Vibration Test.
      d. Conduct Level 2 Noise Test.
      e. Test equipment and installation to verify tightness, operation, and unit heat pump vibration is within manufacturer's submitted maximum.
      f. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.
      g. Test for outdoor sound power at levels.
   2. Electrical Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

3.04 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

SECTION 15762

HEATING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Electric unit heaters (EUH).
   2. Thermostats for unit heater.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):
   1. 302 - Application of Sone Ratings for Non-Ducted Air Moving Devices.

B. American Gas Association (AGA).

C. National Electrical Code (NEC).

D. National Fire Protection Association (NFPA):
   1. 54 - National Fuel Gas Code.
   2. 70 - National Electrical Code (NEC).

E. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (100 V Maximum).

F. Underwriters' Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. NEMA Type 3R enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Provide supports meeting the seismic design criteria as specified in Section 01610 - Project Design Criteria.
   2. Wind design criteria for exterior units as specified in Section 01610 - Project Design Criteria and Section 01614 – Wind Design Criteria.
   3. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
   4. Hot water piping, gas piping, drains, venting, and other appurtenances of unit heaters: Install in accordance with building code, mechanical code, and plumbing code as specified in Section 01410 - Regulatory Requirements, and the NFPA.
   5. Noise levels for unit heaters installed in offices, hallways, or entry areas: Not to exceed 10 Sones as measured in accordance with AMCA Publication 302.
   6. Motors supplied with heating units: As specified in Section 16222.

B. Performance requirements are included in the Heating Unit Schedules at the end of this Section.

C. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system.
   1. Comply with referenced electrical Sections and design to perform system heating functions as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

1.05 SUBMITTALS

A. Submit as specified in Section 01300 - Submittal Procedures and Section 15050 - Common Work Results for Mechanical Equipment.

B. Product data:
   1. Samples: Manufacturer's standard color chips for cabinets finish.
   2. Certificates: Successful testing of burners used in gas unit heaters.
   3. Provide heating units and controls that are listed by UL.

C. Shop drawings:
   1. System layout, mechanical, electrical power, and control diagrams.
   2. Materials.
   3. Supports and seismic bracing calculations and details.
   4. Cut sheets on primary and ancillary equipment.
   5. Sound ratings of fans in Sones in accordance with AMCA Publication 302.

D. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

E. Project closeout documents:
   1. Provide vendor operation and maintenance manual as specified in Section 01730 - Operation and Maintenance Manuals.

F. Warranties.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment from dust and atmospheric exposure as recommended by the unit manufacturer.
   1. Provide temporary closures for equipment openings designed for airflow.

1.07 SITE CONDITIONS

A. As specified in Section 01610 - Project Design Criteria.

1.08 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 ELECTRIC UNIT HEATER (EUH)

A. Manufacturers: One of the following or equal:
   1. Indeeco, Type TRIAD.
   2. Trane, similar models.
   3. Markel, similar models.
   4. Chromalox, similar models.

B. Fan type: Aluminum axial flow:
   1. Provide fan guards.
   2. Dynamically balance.
   3. Fan designed for quiet operation.
   4. Permanently lubricated ball bearings.
   5. Automatic reset thermal overload protection.

C. Heating element characteristics:
   1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
   2. Fin type, Type 316 stainless steel plated heater elements, with elements brazed to common fins, designed for maximum strength and maximum heat transfer.
   3. 3-phase designed for balanced phases.
   4. Over temperature cutout with automatic reset.

D. Features:
   1. Built-in magnetic contactors.
   2. Control transformer for 24 or 120-volt control as indicated in the Heating Unit Schedules.
   3. Required mounting brackets.
   4. Individually adjustable outlet louvers.
   5. Heavy 16 gauge stainless steel louvered outlet grille and plated rear grille.
   6. Cabinet formed of minimum thickness 18-gauge steel with steel stiffeners. Listed for corrosive areas and NEMA 4X hose down requirements.
   7. Controls:
      a. Provide thermostat as specified in this Section.
      b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

E. Finishes:
   1. Casing finish backed enamel in manufacturer's standard color.

2.02 EXPLOSION PROOF ELECTRIC UNIT HEATER (EUH)

A. Manufacturers: One of the following or equal:
   1. Indeeco, Type COMPACT, suitable for Class 1 Div 2 spaces.
   2. Trane, similar models.
   3. Markel, similar models.
   4. Chromalox, similar models.

B. Dirty Duty Corrosion Resistant Construction:
   1. Polyester powder coated fan blade.
   2. Polyester powder coated wiring, conduit and fittings.
   3. NEMA 7 enclosure.

C. Fan type: Aluminum axial flow:
   1. Provide fan guards.
   2. Dynamically balance.
   3. Fan designed for quiet operation.
   4. Permanently lubricated ball bearings.
   5. Automatic reset thermal overload protection.

D. Heating element characteristics:
   1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
   2. Fin type, Type 304 stainless steel tubular heater elements, designed for maximum strength and maximum heat transfer.
   3. 3-phase designed for balanced phases.
   4. Over temperature cutout with automatic reset.

E. Features:
   1. Required mounting brackets.
   2. An adjustable stainless-steel louvered outlet grille directs airflow 45° up or down and a heavy gauge stainless steel rear grille protects against accidental contact with the fan blade.
   3. Housing: Minimum thickness 16-gauge stainless steel shroud.
   4. Thermostat/Controls:
      a. Adjustable thermostat: Factory installed and prewired to the control enclosure.

2.03 THERMOSTATS FOR UNIT HEATERS

A. Type: Wall mounted, heat only with fan AUTO-ON selector switch when fan part of unit and separate system ON-OFF selector switch.

B. Dial or lever temperature setpoint adjustment with 45 to 90 degrees Fahrenheit setpoint range.

C. Setpoint and temperature indication.

D. Control voltage as indicated in the attached Heating Unit Schedules.

E. The use of mercury within the thermostat is not acceptable.

F. Bi-metallic contacts suitable for 1- or 2-stage unit heater control as specified for the heater size or as scheduled.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners, as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Examine and verify that Work is in condition to receive installation specified in this Section.
   1. Take measurements and verify dimensions to ascertain fit of installation.
   2. Verify structural sufficiency to support installation.
   3. Verify that chassis, shafts, and openings are correctly located.
      a. Otherwise cut new openings where required.
   4. Confirm specified thermostat and other controls are compatible with specified equipment.

C. Examine and verify structural details and sections indicated on the Drawings, ascertain adequacy, and determine possible conflicts in dimensions and clearances.

3.02 PREPARATION

A. Before installation, remove dust and debris from equipment and ducts.

B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.03 INSTALLATION

A. Install equipment as indicated on the Drawings and as specified in Section 15050 - Common Work Results for Mechanical Equipment and the manufacturer's written installation instructions.
   1. Provide disconnect switches at the unit heaters wherever indicated on the Drawings, specified in this Section, scheduled and wherever required by code.

B. Anchoring and support: Install anchoring for seismic and wind forces to meet the design criteria specified in Section 01610 - Project Design Criteria.

C. Alignment: Adjust ductwork alignment when necessary to resolve conflicts with architectural and structural features or to resolve conflicts with work of other trades.

D. Install and wire unit heaters and thermostats in accordance with manufacturer's recommendations.

E. Adjust heater units with louvers for optimum air circulation.

F. Provide gas unit heater venting in accordance with mechanical code and plumbing code as specified in Section 01410 - Regulatory Requirements and in accordance with NFPA 54.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 1-day minimum.
      b. Functional Testing: 1 trips, 2-day minimum each.
   3. Training:
      a. Maintenance: 4 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing:
   1. Test as specified in Section 15958 - Mechanical Equipment Testing.
   2. Equipment:
      a. Test witnessing: Not witnessed.
      b. Conduct Level 1 General Equipment Performance Test.
      c. Conduct Level 1 Vibration Test.
      d. Conduct Level 1 Noise Test.
   3. Electrical Instrumentation and Controls:
      a. Test witnessing: Not witnessed.
      b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

D. Functional testing:
   1. Equipment:
      a. Test witnessing: Witnessed.
      b. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.
      c. Conduct Level 2 General Equipment Performance Test.
      d. Conduct Level 2 Vibration Test.
      e. Conduct Level 2 Noise Test.
   2. Electrical Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.
   3. System:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test.
      c. Conduct Level 2 Vibration Test.
      d. Conduct Level 2 Noise Test.
      e. Process test.

3.05 FIELD QUALITY CONTROL

A. Test equipment and installation to verify operation is within manufacturer's standards and that noise levels do not exceed levels specified.

B. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.06 HEATING UNIT SCHEDULES

A. Refer to the Electric Heating Unit Schedule within the Contract Drawings.

END OF SECTION

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SECTION 15812

METAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Aluminum ductwork.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. HVAC Systems-Duct Design.
   2. Seismic Restraint Manual Guidelines for Mechanical Systems.

C. Underwriters Laboratories, Inc. (UL):
   1. 181A - Closure Systems for Use with Rigid Air Ducts.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Custom design and fabricate metal ductwork for the applications indicated on the Drawings and for the conditions specified.
   2. In accordance with SMACNA Manual for gauge of sheet metal, joint types, reinforcement, bracing, hangers and supports, fabrication, and installation.
      a. Sheet metal thicknesses: The greater of that thickness required to in accordance with SMACNA for the design pressure specified and the following minimum thicknesses:

      b. Spacing of hangers and supports:
         1) Provide supports as indicated on the Drawings.
         2) When supports are not shown, provide supports as required in accordance with SMACNA but no greater than the spacing indicated on the Drawings or the following requirements; whichever is less:
            a) Ducts 18 inches and smaller in largest dimension: 8 feet on center.
            b) Ducts over 18 inches in largest dimension: 4 feet on center.
      c. Support connections:
         1) Provide as indicated on the Drawings.
         2) When not indicated on the Drawings, provide in accordance with SMACNA.
         3) As a minimum, all support connections to metal or wood roofs shall be located at roof framing members only.
         4) No penetrations through roof deck, roof membrane, or connections to roof membrane are acceptable.

3. Design pressure: 2 inches water column unless otherwise indicated on the Drawings or specified.
4. Seismic design criteria: As specified in Section 01612 - Seismic Design Criteria and in accordance with SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems.
5. Hanger reinforcement:
    a. Ducts 18 inches and smaller in largest dimension: None.
    b. Ducts over 18 inches and under 30 inches in largest dimension: 1-1/2 inches by 1-1/2 inches by 1/8-inch angles, 8 feet on center.
    c. Ducts 30 inches and larger in largest dimension: 1-1/2 inches by 1-1/2 inches by 1/8-inch angles, 4 feet on center.
6. When ducts are specified with insulation on interior walls, size duct to provide clear inside dimensions indicated on the Drawings.

B. Miscellaneous design details:
1. Changes in duct size:
    a. Use uniformly tapering sections.
    b. Taper not more than 1 inch in 5 inches of run unless otherwise indicated on the Drawings.
2. Bends: With the exception of miter bends, design bends with inside radii equal to duct width or diameter.
    a. Install turning vanes at all 90 degree beds.
3. Duct sleeves: Install duct sleeve when ducts pass through concrete or masonry walls, slabs, or ceilings.
4. Access openings: Install in locations that allow access to dampers, fusible links, controllers, and similar devices.
5. Flexible connections: Install at connections to air handling equipment and at locations indicated on the Drawings.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data:
1. Duct and component material and details of construction.
2. System layout including floor and wall penetrations.
3. Supports and anchoring details.
4. Components used in the duct system including turning vanes, dampers, flexible connections, and access doors.

C. Design data: Seismic design calculations:
1. Design calculations for duct construction as specified in Section 01612 - Seismic Design Criteria and in accordance with SMACNA.

D. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ducts: Aluminum alloy 3003 H14 in accordance with ASTM B209.

B. Flexible connectors: As specified in Section 15820 - Ductwork Accessories.

C. Turning vanes: Match duct material.

D. Reinforcing: Formed or extruded aluminum angles.

E. Ductwork insulation: As specified in Section 15084 - Ductwork Insulation.

2.02 COMPONENTS

A. Duct sleeves:
   1. Sleeve flanges: 4 inches wide.
   2. Size: 2 inches larger than the duct or duct with external insulation.

B. Access openings:
   1. Size: 2 inches less than duct size.
   2. Doors:
      a. Gauge not less than duct sheet.
      b. Provide continuous hinge and latch on outside.
   3. Gasket: Along door periphery.
   4. Visual panel: 1/8-inch thick, clear plexiglass.

C. Turning vanes:
   1. Material: Same as ductwork.
   2. Type:
      a. Single-blade vanes for duct widths less than 36 inches.
      b. Airfoil type vanes for duct widths of 36 inches and greater:
         1) No trailing edge.
   3. Mounted inside rails.
   4. Provide turning vanes for square-turn elbows, smooth radius elbows, and splitters.
   5. Size: 2-inch blades for ducts up to 18 inches, 4-1/2 inch blades for larger ducts.

D. Splitter dampers: Provide at branch take-offs where necessary for balancing system.

E. Extractors:
   1. Components:
      a. Synchronized steel curved blades.
      b. Heavy side rails.
      c. Screw operator.
   2. Provide extractors at take-off from main supply duct adjacent to diffusers, registers, or grilles where splitter is not used.

2.03 FABRICATION

A. Fabricate ductwork to the configuration and dimensions indicated on the Drawings.

B. Dimensions indicate net free area. Increase duct dimensions by thickness of insulation when internal insulation is specified.

C. Do not utilize S clips, duct tape, or externally applied mastic on medium pressure duct systems.

D. Do not use snap lock seams.

E. Provide flexible duct connectors at all connections to fans and other air movement equipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and verify that Work is in condition to receive metallic ductwork as specified in this Section.
   1. Take measurements and verify dimensions on shop drawings to verify fit of installation.
   2. Verify that supports and openings are correctly located.

B. Examine and verify structural details and determine conflicts in dimensions and clearances.

3.02 INSTALLATION

A. Cover ductwork openings with tape, plastic, or sheet metal to reduce the amount of dust or debris which may collect in the system at each of the following times:
   1. At the time of rough installation.
   2. During storage on the construction site.
   3. Until final start-up of the heating and cooling equipment.

B. Before installation remove dust and debris from ducts.

C. Adjust duct alignment where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

D. Install ductwork to provide a system free of buckling, warping, or vibration.

E. Hangers:
   1. Install hangers as indicated on the Drawings.
   2. When hangers are not detailed, conform to SMACNA HVAC System Duct Design and Seismic Restraint Manual standards and the following requirements:
      a. Rectangular ducts concealed in ceiling spaces:
         1) Use metal strap hangers.
         2) Fasten to sides of duct with 2 screws.
         3) Fasten to bottom of duct with 1 screw.
      b. Rectangular ducts in exposed areas:
         1) Install shelf angle trapeze hangers or Unistrut type hangers.
         2) Install sway bracing as required by seismic calculations, minimum 1 brace at right angle to each duct run.
      c. Round ducts in exposed areas:
         1) Install 2 half-round bands with rods bolted to panels.

2) Install sway bracing as required by seismic calculations, minimum 1 brace at right angle to each duct run.

3. Flexible connections: As specified in Section 15820 - Ductwork Accessories.

F. Provide closed-cell neoprene gaskets at flanged joints.

G. Tapes and mastics used to seal ductwork shall be listed and labeled in accordance with UL 181A and shall be marked.

3.03 FIELD QUALITY CONTROL

A. Inspect ductwork under operating conditions.
1. Correct audible leaks and leaks that can be felt with the hand.

B. Test and balance ducting systems as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

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SECTION 15814

FIBERGLASS REINFORCED PLASTIC DUCTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fiberglass reinforced plastic ductwork system, consisting of ducting and including fasteners, field joints, expansion joints, and supports.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings.
   2. RTP-1 - Reinforced Thermoset Plastic Corrosion-Resistant Equipment.

B. American Water Works Association (AWWA):
   1. M45 - Fiberglass Pipe Design.

C. ASTM International (ASTM):
   1. C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   2. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   3. D2105 - Standard Test Method for Longitudinal Tensile Properties of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube.
   4. D2344 - Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates.
   5. D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   1. D2992 - Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings.
   2. D2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
   3. D3982 - Standard Specification for Contact Molded “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Ducts.
   4. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. National Fire Protection Association (NFPA):
   1. 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids.

E. National Institute of Standards and Technology (NIST):
   1. PS 15-69 - Custom Contact-Molded Reinforced-Polyester Chemical Resistant Process Equipment.

F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.03 SUBMITTALS

A. As specified in Sections 01330 - Submittal Procedures.

B. Product data: Composition of materials, configuration of external stiffeners, and flexible connections.

C. Shop drawings:
   1. Drawings showing ductwork layout, dimensions, joint types, and support locations.
   2. Locations of external stiffeners and expansion joints.
   3. Fabrication details.
   4. Support locations, types, and details.

D. Sealed calculations:
   1. Wall thickness calculations based upon design criteria.
   2. Stresses and reaction loads at supports.

E. Manufacturer's Installation Instructions.
   1. Detailed instructions for field butt joints including lay-up sequence, width of each reinforcement layer, and total number of layers.

1.04 QUALITY ASSURANCE

A. Qualification of ducting manufacturer: Manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce custom-made, corrosion resistant fiberglass reinforced plastic products of quality and size specified with a minimum 5 years satisfactory performance record.

B. Submit test results as specified in Section 06608 - Fiberglass Reinforced Plastic verifying that ductwork meets standards specified.
   1. Also, in accordance with Section 06608 - Fiberglass Reinforced Plastic as to the requirements of FRP manufacturing and standard testing.
   2. If there is a conflict between this Section and Section 06608 - Fiberglass Reinforced Plastic, the more stringent requirements shall govern.
      a. Test methods by the manufacturer shall be in accordance with ASTM 2996 and ASTM 2992 (buried pipe).

C. Manufacturer shall provide design calculations for FRP ductwork design and construction. Calculations shall be signed and sealed by licensed engineer registered in the state of the project location.

D. Warranty:
   1. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fiberglass reinforced plastic ductwork:
   1. One of the following or equal:
      a. Bondstrand.

b. NOV Fiber Glass Systems.
c. Spunstrand.
d. Belco Manufacturing.
e. Daniel Mechanical.
f. Engineered Composite Systems.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Ducting for odor control systems:
1. Minimum internal pressure: 20.0 inches water column.
2. Minimum internal vacuum: 20.0 inches water column.

B. Support spacing: As needed to comply with wall thicknesses calculations but not greater than the following:
1. Contact-molded ductwork: Not greater than 5 foot centers.
2. Filament-wound ducts: In accordance with SMACNA standards below:

Duct Inside Diameter (Inches)	Maximum Span (Feet)
3 to 19	10
20 to 29	15
30 to 35	20

C. Minimum flooding: Design ductwork for water accumulation as follows:
1. Rectangular ductwork: 1-inch deep across bottom of duct.
2. Round ductwork: 2 inches deep across bottom of duct.

D. Physical and mechanical properties: Duct shall meet the following standards for physical and mechanical properties:

Pipe Property	Standard	Design Properties	
		Hoop (PSI)	Axial (PSI)
Ultimate Flexural Stress Flexural Modulus	ASTM D2412	50,000 3.05×10^6	18,000 1.0×10^6
Ultimate Tensile Stress Tensile Modulus	ASTM D2105	52,000 1.5×10^6	7,485 1.56×10^6
Ultimate Shear Strength		Approximate Typical Values (PSI)	
Interlaminar Cross	ASTM D2344	2130-2730 15,000	
Density	ASTM D792	0.065-0.072 lb./ln^3	

E. Design tensile stress:
   1. Calculations for design of wall thickness assume a laminate ultimate tensile stress of 9,000 pounds per square inch maximum.
   2. Decrease ultimate tensile stress as appropriate to the laminate design.
      a. Round ducting: The maximum allowable design tensile stress shall be the ultimate tensile stress divided by 5.
      b. Rectangular ducting: The maximum allowable design tensile stress shall be the ultimate tensile stress divided by 10.

2.03 DUCTWORK MATERIALS

A. As specified in applicable portions of Section 06608 - Fiberglass Reinforced Plastic.

B. Minimum corrosion liner:
   1. Interior surfacing "C" or Nexus veil as specified for the service environment.
   2. Exterior surfacing: “C” or “A” veil.
   3. Remainder 1-1/2 ounce per square foot mat to total minimum thickness of 0.096 inches on surface exposed to the service environment.
   4. Duct shall be resistant to the following in accordance with ASTM C582:

Sulfuric Acid	75 percent	At 100 degrees Fahrenheit
Nitric Acid	20 percent	At 100 degrees Fahrenheit
Sodium Hydroxide	50 percent	At 100 degrees Fahrenheit
Hydrofluoric Acid	20 percent	At 100 degrees Fahrenheit

C. Ultra violet stabilizer:
   1. All exposed external surfaces of all FRP ductwork installed outdoors shall be provided with protection against ultraviolet degradation and weather erosion.
   2. The duct shall carry the flame spread rating of 25 or less in accordance with ASTM E84 and a smoke contribution rating in excess of 1,000 in accordance with NPFA 91.
   3. External duct protection shall be provided by an ultraviolet stabilizer added to the final coat or resin that also incorporates paraffin wax curing elements and color pigment.
   4. An alternative system to polyurethane paint with color pigments may be used if approved by the Owners Designated Representative.

D. Resin:
   1. The external surface and structural layers of all FRP ductwork shall carry a flame spread rating of 25 or less in accordance with ASTM E84 and a smoke contribution of 50 or less in accordance with NFPA 91.
   2. Premium vinyl ester as follows unless otherwise recommended by the resin manufacturer for the service environment:
      a. Resin for structural layers: Resin with sufficient antimony trioxide or pentoxide for Class I fire rating.
      b. Manufacturers: One of the following or equal:
         1) Ashland, Hetron 992FR.
         2) Reichhold Dion, VER 9300FR.

E. Color: Add pigment to the exterior surface resin coat such that the color of the duct will be similar to paint used for equipment, except that ducting for air conditioning systems which are concealed above suspended ceilings need not be pigmented. Color selected by Owner.

F. Provide fasteners, field joints, expansion joints, and supports required for complete installation of a duct system.

G. Flanges:
   1. All flanges shall be hand laid up to the thickness specified in accordance with ASTM D3982.
   2. FRP flanges shall be made of the same materials as the FRP ductwork.
   3. Flange bolt hold pattern as well as flange dimensions, shall be in accordance with NIST PS 15-69 Tables 2 and 5 for duct and pipe, respectively, except for thickness. Thickness of flange shall be a minimum of 1/2 inch.
   4. Flanges shall be manufactured using the hand lay-up technique and shall be integral to the duct in accordance with ASME RTP-1. Filament-wound and/or random chopped methods of constructing flanges will not be acceptable.

Pipe Diameter, Inches	Minimum Flange Thickness, Inches
Less Than 12	1/2
12-24	1/2
25-41	5/8
42-60	3/4

2.04 DUCTWORK FABRICATION

A. Hand lay-up or filament wound construction as specified in Section 06608 - Fiberglass Reinforced Plastic.
   1. Provide wall thickness necessary to comply with design criteria but not less than the following minimum thicknesses.
   2. Structural wall thicknesses shall not include the thickness of the interior corrosion barrier, inner surface, and interior layer:

Duct Size	Round Ducting (wall thickness, inches)	Rectangular Ducting (wall thickness, inches)	Buried Ducting (wall thickness, inches)
For 18 inch & smaller ducts	0.1875	0.25	0.34
20 to 36 inch ducts	0.25	0.375	0.42
42 to 54 inch ducts	0.375	0.500	0.60
60 to 72 inch ducts	0.438	0.625	0.625

B. Fittings:
   1. Type: Hand lay-up contact molded.
   2. Resin: Identical to and with same strength as resin used for FRP ductwork.
   3. Wall thickness: At least equal to the thickness of the thickest adjacent ducting.
   4. Internal diameter: Equal to the adjacent duct.

5. Tolerance:
    a. Angles for all fittings shall be within 1 degree for up to 30-inch diameter duct.
    b. Angles for all fittings shall be within 1/2 degree for over 30-inch diameter and above duct.
6. Round standard elbows:
    a. Standard elbow centerline radius shall be equal to 1-1/2 times the diameter unless otherwise indicated on the Drawings.
    b. Standard elbows up to 24-inch diameter shall be smooth radius elbows. Standard elbows of 26-inch diameter and greater may be mitered sections as follows:
        1) 0 to 44 degree elbows shall contain 1 mitered joint and 2 sections.
        2) 45 to 80 degree elbows shall contain a minimum of 2 mitered joints and 3 sections.
        3) Elbows greater than 80 degrees shall contain a minimum of 4 mitered joints and 5 sections.
    c. Provide turning vanes in all round mitered elbows. Round elbow turning vanes shall be of FRP construction, solid or double wall construction with an airfoil shaped profile.
7. Rectangular elbows:
    a. Fittings shall be factory manufactured to meet the specified design criteria and in accordance with approved submittals. Factory install reinforcing ribs as required to meet the specified deflection requirements and to provide a system free from pulsing, warpage, sagging, and undue vibration.
    b. Provide turning vanes in all rectangular elbows. Rectangular elbow turning vanes shall be of FRP construction, solid or double wall construction with an airfoil shaped profile.

C. Joints:
1. Flanged:
    a. Flanged in accordance with ASTM D3982 and bolt hold patterns in accordance with NIST PS 15-69, Table 2.
    b. Flanged joints shall be provided at the following locations:
        1) At each damper and each item of equipment to facilitate disassembly.
        2) At each change in material.
        3) Where indicated on the Drawings.
    c. Gaskets for flanged joints: 1/8-inch neoprene over full flange face.
    d. Bolt nuts and washers: Type 316 stainless steel.
2. Butt and strap welded:
    a. Field butt and strap welded joints shall be provided at the following locations:
        1) 12 inches from any increasing or decreasing cross-section of pipe.
        2) Where the pipe to be joined has the same diameter.
    b. Thickness of butt and strap joint overlays: At least equal to the thickness of the thickest adjacent duct.
    c. Field weld kits:
        1) All necessary fiberglass and reinforcing material shall be supplied pre-cut and individually packaged for each joint.
        2) Bulk Glass rolls will not be acceptable.

2.05 FLEXIBLE CONNECTIONS

A. Flexible connection shall be provided as indicated on the Drawings. When flexible connections are not shown, they shall be provided at all duct to rotating equipment connections.

B. FL-3, Duct to Equipment Heavy Duty Flexible Connection:
   1. Materials: EPDM rubber vulcanized with minimum of 1 ply of reinforcing fabric; 3/16 inch thick.
   2. Unit shall have minimum movement of:
      a. Axial compression: 2.25 inches.
      b. Axial extension: 1.25 inches.
      c. Lateral offset: 1.25 inches.
   3. Provide 3/8-inch thick by 2-inch wide pre-drilled retaining rings/back-up bars to clamp the expansion joints into the ducting system.
   4. The expansion joint shall be of fully molded construction. Splices will not be allowed in the body of the expansion joint.
   5. Manufacturers: One of the following or equal:
      a. Proco Series 500, Style 530 Fabric Fan Connector.
      b. Holz Rubber Style 952 Arch Design Expansion Joint.

2.06 EXPANSION JOINTS

A. Expansion joints shall be provided as indicated on the Drawings. When expansion joints are not shown, they shall be provided in above grade duct at maximum spacing of 40 foot centers.

B. Construction:
   1. Body: EPDM.
   2. Reinforcing: Multiple layers (2 minimum) of impregnated polyester or Kevlar tire cord fabric.
   3. Flange rings: Type 316 stainless steel or minimum 3/4 inch thick FRP.
   4. Hardware/Fasteners: Type 316 stainless steel.
   5. Minimum pressure rating: 1 pounds per square inch.
   6. Minimum vacuum rating: 1 pounds per square inch.
   7. Minimum operating temperature: 175 degree Fahrenheit.
   8. Connections: Flanged in accordance with NIST PS 15-69, Table 2.
   9. Seamless construction built as on continuous piece. Wrapped, seamed, or spliced type expansion joints are not acceptable.
   10. Provide Type 316 stainless steel control rods.

C. Minimum movement:
   1. Axial compression: 2.25 inches.
   2. Axial extension: 1.25 inches.
   3. Lateral offset: 1 inch.

D. Manufacturers: One of the following or equal:
   1. Daniel Co., DanFLEX Model 101.
   2. Mercer Rubber Co., Model ME for Rectangular, Model MI-9 for Round.

2.07 DUCT SUPPORTS

A. Provide duct supports as indicated on the Drawings.

B. Protect the duct from clamping force of strap hangers with a 1/8-inch thick layer of neoprene pad.

C. When anchors are required, they shall be externally bonded to the duct. Drive screws or other penetrations of the duct linter are not permitted.

D. When duct supports are not indicated on the Drawings provide supports and seismic bracing in accordance with the SMACNA Design Manual.

PART 3 EXECUTION

3.01 INSTALLATION

A. All **ductwork** shall be fabricated and erected where indicated on the Drawings or as specified in this Section. Ductwork shall be rigidly supported and secured in an approved manner.

B. Install ductwork parallel to walls and/or roof and vertically plumb.

C. Bracing and vibration isolators shall be installed, where necessary, to eliminate vibration, rattle and noise.
   1. Hangers shall be installed plumb and securely suspended from supplementary steel or inserts in concrete slabs.
   2. Lower ends of hanger rods shall be sufficiently threaded to allow for adequate vertical adjustment.
   3. Building siding and metal decking shall not be used to hang ductwork.

D. Contractor shall not install any equipment or materials until the Owners Designated Representative has approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

E. Wherever ducts are divided, the cross-sectional area shall be maintained. All such changes must be approved and installed as directed by the Owners Designated Representative or as approved on shop or erection drawings.

F. Do not remove or alter factory installed duct reinforcing ribs except as required to accommodate duct alterations due to unexpected field conditions.
   1. Notify the Owners Designated Representative prior to starting any field modifications involving ductwork structural reinforcing members.
   2. Submit additional design calculations to demonstrate structural design integrity of ductwork and fittings requiring reinforcing modifications in the field.

G. No ductwork or components shall be shipped prior to complete resin cure.

H. Cover ductwork openings with tape, plastic, or sheet metal to reduce the amount of dust or debris which may collect in the system at each of the following times:
   1. At the time of rough installation.
   2. During storage on the construction site.
   3. Until final start-up of the heating and cooling equipment.

I. Before installation remove dust and debris from ducts.

J. Install products in accordance with shop drawings and manufacturer's instructions. Drawings indicate general routing only and shall be modified as necessary.

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SECTION 15815

FLEXIBLE DUCTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Flexible ductwork.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. HVAC Duct Construction Standards - Metal and Flexible.
   2. Seismic Restraint Manual: Guidelines for Mechanical Systems.

C. Underwriters Laboratories. Inc. (UL).
   1. 181 - Factory-Made Air Ducts and Air Connectors.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Spacing of hangers and supports: As required in accordance with SMACNA and as required to maintain UL listing for the ducting but no greater than the spacing indicated on the Drawings or recommended by the manufacturer.
   2. Changes in duct size: Use uniformly tapering aluminum connector sections; taper not more than 1 inch in 5 inches of run unless otherwise indicated on the Drawings.
   3. Connections to registers: Support registers independently from ducting; collars to be 2 inches minimum length; attach duct to collar with stainless steel draw band.
   4. Duct dimensions on the Drawings indicate net inside diameter; increase duct dimensions as required to obtain indicated diameter.
   5. Meet UL 181 and be listed as Class 1 air duct in accordance with NFPA 90A.

1.04 SUBMITTALS

A. Shop drawings:
   1. Duct material and details of construction.
   2. System layout.
   3. Supports and anchoring details.
   4. Other materials and components for duct systems.

B. Product data: Products and components used in the duct system including turning vanes, dampers, flexible connections, and access doors.

C. Design data - seismic design calculations:
   1. Design calculations for duct support construction as specified in Section 01612 - Seismic Design Criteria and in accordance with SMACNA.

PART 2 PRODUCTS

2.01 NON-METALLIC FLEXIBLE DUCTING

A. Manufacturers: The following or equal:
   1. C. A. Schroeder, Inc., Casco Silent Flex II.

B. Characteristics:
   1. Liner: Spunbonded non-woven nylon porous surface for sound absorption.
   2. Wire reinforcement: High carbon spring steel helix with zinc coating.
   3. Insulation: Fiberglass with thermal resistance R rating of 4.2.
   4. Outer jacket: Gray polyethylene jacket rated as UL Class 1 with .05 perm rating.
   5. End treatment: Adjustable male/female aluminum collars with stainless steel clamps to hold duct to collar.
   6. Design pressure: Positive 1.5 inches and negative 0.5 inches water column unless otherwise indicated on the Drawings or specified.
   7. Air velocity: Rated for up to 4,000 feet per minute continuous operation.
   8. Friction loss: Not more than 0.15 inches water column per 100 feet at 500 cubic feet per minute for 12-inch diameter duct.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and verify that Work is in condition to receive ductwork as specified in this Section.
   1. Take measurements and verify dimensions on shop drawings to ascertain fit of installation.
   2. Ascertain that supports and openings are correctly located.

B. Examine and verify structural details and determine conflicts in dimensions and clearances.

3.02 INSTALLATION

A. Before installation remove dust and debris from ducts.

B. Adjust duct alignment where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

C. Length of flexible duct between the rigid ductwork and air distribution terminal shall not exceed 5 feet unless otherwise indicated on the Drawings.

D. Hangers: Install hangers as indicated on the Drawings. When hangers are not detailed, in accordance with SMACNA Duct Design, and Seismic Restraint Manual standards and the following requirements:
   1. Ducts concealed in ceiling spaces:
      a. Use galvanized steel strap hangers.

E. Bends: Minimum bend radius to duct centerline, 1 duct diameter.

F. Provide non-metallic flexible ducting as indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Inspect ductwork under operating conditions. Correct audible leaks and leaks that can be felt with the hand.

B. Test and balance ducting systems as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

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SECTION 15820

DUCTWORK ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Dampers and damper operators.
   2. Diffusers, grilles, and registers.
   3. Screens.
   4. Flexible duct connectors.
   5. Other ductwork accessories.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   2. 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Uniform Building Code (UBC).

D. Underwriters Laboratories, Inc. (UL):
   1. 555 - Fire Dampers.
   2. 555S - Smoke Dampers.

1.03 DEFINITIONS

A. Dampers, diffusers, grilles, and registers specified are indicated on the Drawings by the abbreviations listed below. Each abbreviation is followed by a hyphen and a number to designate the required style of unit:
   1. BD: Balancing Damper.
   2. BDD: Backdraft Damper.
   3. FL: Flexible Duct Connector.
   4. RR: Return Register or Grille.
   5. SR: Supply Register, Grille, or Diffuser.

B. NEMA Type 1 enclosure in accordance with NEMA 250.

C. Return registers:
   1. RR designation includes wall, ceiling, and duct mounted air exhaust or return devices including diffusers and grilles with or without control dampers.
   2. When no return register style is indicated on the Drawings, provide Style RR-3; provide 4 inch flanged drop frame when duct mounting indicated.

D. Supply registers:
   1. SR designation includes wall, ceiling, and duct mounted air supply devices including diffusers and grilles with or without control dampers.
   2. When no supply register style is indicated on the Drawings, provide Style SR-3; provide 4 inch flanged drop frame when duct mounting indicated.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

PART 2 PRODUCTS

2.01 DAMPERS

A. Manufacturers:
   1. Provide dampers manufactured by the same manufacturer.
   2. Dampers:
      a. Manufacturers: One of the following or equal:
         1) One manufacturer's model is listed with each style, similar models from other listed vendors are acceptable:
            a) Ruskin Manufacturing.
            b) American Warming and Ventilating.
            c) Swartwout.

B. Materials:
   1. Metallic ductwork: Aluminum for aluminum duct work; aluminum or galvanized steel for galvanized steel ductwork unless specified otherwise with styles.
   2. Fiberglass reinforced plastic ductwork: Fiberglass reinforced plastic where not otherwise specified.

C. Components: Include specified damper type with frame actuators, clips, connectors, and other accessories necessary for mounting; provide locking quadrant manual actuator or electric actuator as indicated on the Drawings.

D. Volume control and balancing dampers (BD):
   1. BD-2, Style 2 Balancing Damper, Commercial Round Manual Balancing Damper:
      a. Service: Manual balancing of office or laboratory air distribution systems; suitable for up to 1,500 feet per minute velocity and 3 inch water column pressure.
      b. Size and installation: Size as indicated on the Drawings suitable for in-line mounting in round ducting.
      c. Frame: 20 gauge minimum galvanized steel.
      d. Blade: 20 gauge minimum galvanized steel.
      e. Blade axle: Square plated steel with molded synthetic bearings; provide factory mounted locking hand quadrant.
      f. Finish: Mill galvanized.
      g. Manufacturers: One of the following or equal:
         1) Ruskin, Model MDRS25.

2) Greenheck, similar model.

2. BD-3, Style 3 Balancing Damper, Commercial Rectangular Control Damper:
   a. Service: Office or laboratory air distribution systems; suitable for up to 6,000 feet per minute velocity and 13 inches water column pressure.
   b. Size and installation: Size as indicated on the Drawings suitable for mounting in rectangular ducting.
   c. Frame: 0.125-inch thick 6063T5 aluminum with mounting flanges on both sides.
   d. Blades: Opposed airfoil shape 6063T5 aluminum.
   e. Blade axles: Hexagonal plated steel with molded synthetic bearings.
   f. Seals: Extruded vinyl blade edge; flexible metal compressible type for jamb as required.
   g. Finish: Mill Aluminum.
   h. Manufacturers: One of the following or equal:
      1) Ruskin, Model CD50.
      2) Greenheck, similar model.
3. BD-7, Style 7 Balancing Damper, Fiberglass Control Round Damper:
   a. Service: Air systems up to 30 inches water column; up to 4,000 feet per minute velocity and up to 72 inches diameter.
   b. Size and installation: Size as indicated on the Drawings suitable for flange mounting in round ducting.
   c. Damper frame: one piece construction, resin rich interior corrosion barrier with minimum thickness of 100 mills. Constructed of structural lay-up of alternate layers of chopped strand mat and woven roving to conform to ASME/ANSI ATP-1 and ASTM D3982. The glass to resin ratio shall be a minimum of 35% glass to 65% resin. Wall thickness, flange thickness, drilling pattern and width shall conform to ASTM D3982 Table 1.
   d. Exterior damper surface shall contain UV inhibitors and a gelcoat. Color shall be match duct.
   e. Blade: constructed of the same material as the damper frame and have a resin rich surfacing veil on both sides. Blade stiffeners shall be FRP or FRP encapsulated as required for stiffness. The damper blade shall be constructed of the same material as the damper frame and shall have a resin rich surfacing veil on both sides. Blade stiffeners shall be FRP or FRP encapsulated as required for stiffness.
   f. Axles: 316 stainless steel or pultruded FRP.
   g. Leakage shall not exceed 3 cfm per square foot at 12” w.g.
   h. Damper shall be provided with stainless steel hand locking quadrant, gear operators, chain wheel operators, or other actuation devices as required in this specification.
   i. Leakage shall not exceed 3 cfm per square foot at 12” w.g. or 5.25 cfm per square foot at 30” w.g. as required in this specification for isolation.
   j. Damper Operator: provide with stainless steel hand locking quadrant damper operator.
   k. All interior metal shall be 316 stainless steel. Gaskets shall be EPDM.
   l. FRP fabrication shall meet or exceed quality requirements of ASTM D 3982 and ASME/ANSI ATP-1.
   m. Manufacturers: The following or equal:
      1) MK Plastics, Model K-RD-502.

E. Backdraft dampers (BDD):

1. BDD-3, Style 3 Backdraft Damper, Heavy Duty Counterbalanced Backdraft Damper:
    a. Service: Low pressure opening at 0.01 inches water column in rectangular ducts or wall mounting for spot air velocities up to 2,500 feet per minute; weather resistant for exhaust applications.
    b. Size and installation: Size as indicated on the Drawings and suitable for mounting as indicated.
    c. Frame: 2.25 inches deep, 0.125-inch minimum thickness 6063T5 aluminum with insect screen and water stop.
    d. Blades: 0.070-inch minimum thickness 6063T5 aluminum with Zytel bearings, elastomer edge seals, and aluminum tie-bar; blades require no more than 4.25 inches clearance beyond frame when fully open.
    e. Counterbalance: Zinc plated bar on blades; adjustable down to 0.01 inch water column opening.
    f. Finish: Kynar in manufacturer's standard colors to be selected by the Engineer.
    g. Manufacturers: The following or equal:
        1) Ruskin, Model CBD6.

2.02 DIFFUSERS, GRILLES, AND REGISTERS

A. Manufacturers:
    1. Provide diffusers, grilles, and registers manufactured by the same manufacturer.
    2. Diffusers, grilles, and registers: One of the following or equal. One manufacturer's model is listed with each style, similar models from other listed vendors are acceptable:
        a. Titus Manufacturing Corp.
        b. Tuttle and Bailey.
        c. Kees, Inc.
        d. Metal Industries, Inc., (MetalAire).
        e. Krueger.

B. Materials:
    1. For metallic ductwork: Aluminum for aluminum duct work; aluminum or galvanized steel for galvanized steel ductwork unless specified otherwise with styles.
    2. For fiberglass reinforced plastic ductwork: Fiberglass reinforced plastic where not otherwise specified.

C. Components: Include specified style with frame, clips, connectors, and other accessories necessary for mounting.

D. Appearance: Similar for units in same room or space.

E. Finishes:
    1. In chlorine, hypochlorite, or sodium bisulfite storage or pumping rooms and building exhaust systems for these areas: Coat with two 1-1/2 mils thick coats of synthetic vinyl plastic coating suitable for use in gas contaminated exhaust system including chlorine, sulfur dioxide, ozone, or a combination thereof of such gases:
        a. Manufacturers: One of the following or equal:

1) Bisonite M, Amercoat® Number 23 and 55.
2) Plasite, 2441.

2. In laboratory room exhaust systems: Coat with 2 finish coats of synthetic resin over prime applied on clean surface suitable for use in a laboratory exhaust system:
   a. Manufacturers: The following or equal:
      1) Carboline Eisen-Heiss.
3. In other locations, specified factory standard with the style requirements of a color selected by Engineer from standard manufacturer's colors.

F. Supply diffuser, grille, and register styles:
1. SR-2, Supply Register Style 2:
   a. Size and installation: Square or rectangular size as indicated on the Drawings framed for surface mounting on gypsum or T-bar ceilings.
   b. Faceplate: Removable square or rectangular pattern diffuser with gasket at frame to ceiling mount.
   c. Core: Adjustable vanes with rectangular or round neck to match ducting.
   d. Damper: Provide opposed blade volume control damper suitable for use with ducting type; damper to be adjustable through the face of the unit.
   e. Materials: Aluminum frame, core, damper, and faceplate.
   f. Manufacturers: The following or equal:
      1) Titus, Model TDCA-AA.
2. SR-3, Supply Register Style 3:
   a. Size and installation: Rectangular grille size as indicated on the Drawings framed for surface mounting on gypsum or directly mounted on exposed ducting; provide 4 inch flanged drop frame when duct mounted.
   b. Faceplate: Removable grille with double deflection blades spaced at 3/4 inch; front blades parallel to long dimension; provide gasket at frame for sealing.
   c. Core: Adjustable vanes with rectangular or round neck to match ducting.
   d. Damper: Provide opposed blade volume control damper suitable for use with ducting type; damper to be adjustable through the face of the unit.
   e. Materials: Aluminum frame, core, damper, and faceplate.
   f. Manufacturers: One of the following or equal:
      1) Titus, Model 272FL.
      2) Krueger, Model 5880H.

G. Return diffuser, grille, and register styles:
1. RR-1, Return Register Style 1:
   a. Size and installation: 24-inch by 24-inch panel and frame suitable for suspended T-bar lay in ceiling.
   b. Faceplate: Removable, perforated with 3/16 inch holes on 1/4 inch centers matching SR-1 in appearance.
   c. Core: When connected to ducting, provide suitable rectangular or round neck connection to ducting type indicated on the Drawings.
   d. Damper: When connected to ducting, provide opposed blade volume control damper suitable for use with ducting type; damper to be adjustable through the face of the unit.
   e. Materials: Aluminum frame, core, damper, and faceplate.
   f. Manufacturers: The following or equal:
      1) Titus, Model PAR-AA.
2. RR-3, Return Register Style 3:

a. Size and installation: Rectangular grille with size as indicated on the Drawings framed for surface mounting on gypsum or directly mounted on exposed ducting; provide 4 inch flanged drop frame when duct mounted.
b. Faceplate: Removable grille with fixed blades spaced at 3/4 inch; front blades parallel to long dimension with 35 degree deflection; provide gasket at frame for sealing.
c. Core: When connected to ducting, provide suitable rectangular or round neck to match ducting; when filter indicated on the Drawings, provide 1-inch deep filter frame and hinged face with 1/4-turn fasteners.
d. Damper: When connected to ducting, provide opposed blade volume control damper suitable for use with ducting type; damper to be adjustable through the face of the unit.
e. Materials: Aluminum frame, core, damper, and faceplate.
f. Manufacturers: The following or equal:
1) Titus, Model 350FL or Model 350FF1.

3. RR-6, Return Register Style 6:
a. Service: Return air in corrosive environments.
b. Size and installation: Rectangular grille with size as indicated on the Drawings framed for directly mounted on exposed ducting; provide 4 inch flanged drop frame when duct mounted.
c. Faceplate: Removable grille with fixed blades spaced at 3/4 inch; front blades parallel to short dimension with 45 degree deflection; provide gasket at frame for sealing.
d. Core: Provide suitable rectangular or round neck to match ducting; when filter indicated on the Drawings, provide 1 inch deep filter frame and hinged face with 1/4 turn fasteners.
e. Damper: When connected to ducting, provide opposed blade volume control damper suitable for use with ducting type; damper to be adjustable through the face of the unit.
f. Materials: Type 316 stainless steel frame, core, damper, and faceplate.
g. Manufacturers: The following or equal:
1) Titus, Model 350RS-SS with opposed blade damper.

2.03 SCREENS

A. Characteristics and features:
1. Bird screen: 1/2-inch mesh by 14 gauges.
2. Insect screens: 18 by 14 mesh.
3. Screens and frames, same material as ductwork, hood, louver, fan, or equipment connected to screen.
4. Screens secured in frames.

2.04 FLEXIBLE CONNECTIONS

A. Provide flexible duct connectors at all connections to fans and other air movement equipment as indicated on the Drawings.

B. FL-1, Duct to Duct Flexible Connection:
1. Fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 4 inches of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.
2. Interior locations:

a. Fabric for flexible connections installed inside office areas shall be Neoprene coated glass fabric suitable for a temperature range of -20 degrees Fahrenheit to 180 degrees Fahrenheit and shall have a weight of at least 27 ounces per square yard and a thickness of 0.024 inches.
b. Manufacturers: The following or equal:
1) Ventfabrics, “Ventglas”.

3. Exterior locations:
a. Fabric for flexible connections exposed to sunlight or the weather shall be glass fabric coated with chlorosulfurated polyethylene suitable for a temperature range of -10 degrees Fahrenheit to 250 degrees Fahrenheit and shall have a weight of at least 24 ounces per square yard and a thickness of 0.019-inch.
b. Manufacturers: The following or equal:
1) Ventfabrics, “Ventlon”.

PART 3 EXECUTION

3.01 PREPARATION

A. Before installation, remove dust and debris from ducts and accessories.

3.02 INSTALLATION

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

B. FL-1 Flexible Connections:
1. Install at building expansion joints and as indicated on the Drawings.
2. Install with collar and metal band to form airtight joints.
3. Install with minimum 4 inches of slack in fabric.
4. Exterior locations: Install sheet metal weather cover over fabric.
5. Duct alignment shall be a maximum of 1/2-inch offset.
6. The minimum/maximum gap shall be 2-inches and 6-inches.
7. Lap longitudinal joints and glue per manufacturer’s recommendations.

3.03 FIELD QUALITY CONTROL

A. Set grilles, dampers, and diffusers to achieve flows and flow patterns indicated on the Drawings and test finished system as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

B. Mark final balance positions on all manual damper actuators with paint pen in a distinctive color.

END OF SECTION

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SECTION 15830

FANS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fans, including:
   1. Type 4 - Sidewall propeller fans.
   2. Type 5 - Centrifugal ceiling exhaust fans.
   3. Type 10 – Circular Hood Axial Supply Fans
   4. Type 14 - Centrifugal sidewall exhaust fans.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9, Load Ratings and Fatigue Life for Ball Bearings.
   2. 11, Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc. (AMCA):
   1. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   2. 211, Certified Rating Program- Product Rating Manual for Fan Air Performance.
   3. 300, Reverberant Room Method for Sound Testing of Fan.
   4. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   1. 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   2. 68 - Laboratory Methods of Testing to Determine Sound Power in a Duct.

D. ASTM International (ASTM):
   1. A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   2. D4167 - Standard Specification for Fiber Reinforced Plastic Fans and Blowers.
   3. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. National Electrical Code (NEC).

F. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

G. National Fire Protection Association (NFPA):
   1. 90A - Standard for Installation of Air Conditioning and Ventilating Systems.
   2. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

H. National Roofing Contractors Association (NRCA).

I. Occupational Safety and Health Administration (OSHA).

J. Underwriters' Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. As used in this Section and on the drawings, abbreviations and Fan Schedule headings have the following meaning:
   1. SF or SPF: Supply Fan.
   2. EF or EXF: Exhaust Fan.
   3. Type: Fan type as specified in this Section.
   4. SP or ESP: Fan External Static Pressure in inches water column.
   5. Size: Nominal fan blade or wheel diameter in inches.
   6. Hp: Fan motor horsepower.
   7. V/Ph: Fan motor voltage and power phases.

B. NEMA:
   1. Enclosures shall be in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Provide fans that have sharply rising pressure characteristics which extend throughout the operating range and continue to rise beyond the efficiency peak.
   2. Provide fans that peak as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.
   3. When scheduled, provide guided vibration isolator for fans, so that not more than 10 percent of the vibration amplitude of the fan and motor is transmitted to the supporting structure.
   4. Design fan inner scroll and air stream surfaces to maintain smoothness for entire fan service life.
   5. Seismic supports: Seismic design criteria as specified in Section 01612 - Seismic Design Criteria.
   6. Wind supports for exterior units: Wind design criteria as specified in Section 01614 - Wind Design Criteria.
   7. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
   8. Applicable portions as specified in Section 15050 - Common Work Results for Mechanical Equipment.
   9. Motors supplied with fans: TEFC, IEEE 841 Compliant, NEMA premium efficiency, Class F insulation, Class B temperature rise, 1.15 service factor; provide motor voltage phases and speed as scheduled; non-overloading on any point of the fan curve including belt losses.
   10. Roof curbs: Designed in accordance with NRCA standards.
   11. Insulation and adhesives: Meet NFPA 90A requirements for flame spread and smoke generation.
   12. Belt drive systems: Adjustable for minimum within 5 percent speed change, rated for 1.5 times maximum horsepower motor available for the scheduled fan size or model.
   13. Screens: Provide bird or insect screen as specified with the fan type or as listed on the Fan Schedule:
      a. Bird screen: Stainless steel; 0.5-inch mesh 18-gauge.
      b. Insect screen: Stainless steel mesh and frame.

14. Finishes: When not specified with fan type, coat ferrous metals as specified in Section 09960 - High-Performance Coatings.
15. Accessories: Provide accessories specified and those scheduled.
16. Provide fans with fire/smoke control system as specified under paragraph Fire/Smoke Control System Design Requirements.

B. Performance requirements:
1. Performance requirements are included in the Fan Schedule located at the end of this Section.
2. Fan performance: Rated and licensed to bear the AMCA label in accordance with AMCA 210 and AMCA 211.
3. Total sound power levels in the 8 octave band range as measured in accordance with ASHRAE 68, AMCA 301, or AMCA 300 as appropriate for each fan: Not to exceed the lesser of the following or the Sones levels on the Fan Schedule.

Sound Power Level, decibel levels referenced to 10-12 watts								
Frequency, Hz	63	125	250	500	1,000	2,000	4,000	8,000
General	100	98	94	88	84	84	78	75

4. Air filters supplied with fans: 25 to 30 percent dust spot efficiency when rated per ASHRAE Testing Standard 52.2.
5. Bearings: Rated per ABMA 9 or 11 for a L10 life rating of not less than 50,000 hours; provide greater life when specified with each fan type.

C. Electrical and control system design:
1. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system. Design to perform the system ventilating functions with the control systems as specified in Section 15936 - Instrumentation and Control Devices for HVAC or as indicated on the Drawings and as specified in the following Sections:
   a. Section 16550 - Grounding.
   b. Section 16200 - Wires Conductors and Cable 600V and Below.
   c. Section 16150 - Raceways, Fittings and Supports..
   d. Section 16130 - Boxes and Cabinets.
   e. Section 16300 - Wiring Devices.
   f. Section 16222 - Electric Motors, Induction, 600V and Below.
   g. Section 16600 - Disconnect Switches and Enclosed Circuit Breakers.

D. Fire control system design requirements:
1. Provide all supply, exhaust, and odor control fans greater than or equal to 2,000 cubic feet per minute with smoke control system including the following minimum components.
   a. Duct or fan mounted smoke detector as specified in Section 15936 - Instrumentation and Control Devices for HVAC.
   b. Fan interlock to shut down fan upon smoke detection.
   c. Signals for fans and smoke detectors to and from local fire alarm control panel if a fire alarm control panel is part of project design.

d. Provide all wire, conduit, end of line resistors, and other electrical equipment for complete functioning smoke control system. Provide in conformance with the electrical, mechanical, and instrumentation Drawings. When no electrical design for smoke control system is indicated, Contractor shall provide design and installation of the smoke control system.

1.05 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Product data:
   1. Materials.
   2. Primary and ancillary equipment.
   3. Sound Power Level in each of 8 octave bands and overall Sones.
   4. Fan system layout, mechanical, electrical power, and control diagrams.
   5. Supports, vibration isolators, and seismic bracing calculations and details.
   6. Calculated fan vibration levels and field-testing method.
   7. Bearing life.
   8. Fan performance curves showing specified operating condition.

C. Provide vendor operation and maintenance manual as specified in Section 01730 - Operation and Maintenance Manuals.
   1. Furnish bound sets of installation, operation, and maintenance instructions for each type fan.

D. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.

1.06 QUALITY ASSURANCE

A. Provide fans:
   1. Listed by UL.
   2. Rated in accordance with AMCA.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver units in 1 piece, factory assembled, internally wired, and lubricated.

B. Protect equipment from dust and atmospheric exposure as recommended by the unit manufacturer.
   1. As a minimum provide temporary closures for equipment openings designed for airflow.

1.08 EXTRA MATERIALS

A. Provide 2 extra sets (3 sets total) of filters per installed fan for fans specified with filters.

B. Provide 1 extra set of belts per installed fan for fans specified with belt drives.

PART 2 PRODUCTS

2.01 TYPE 4, SIDEWALL PROPELLER FANS

A. Manufacturers: One of the following or equal:
   1. Greenheck, Model SBCS.
   2. Loren Cook, similar model.
   3. Penn Ventilator, similar model.

B. Type: Wall-mounted, low noise propeller type, packaged unit.
   1. Fan: Statically and dynamically balanced propeller with aluminum blades, unless noted otherwise.
   2. Motor: Permanently lubricated; selected to avoid running in the service factor.

C. Accessories:
   1. Motor and fan side OSHA guards.
   2. Wall mount collar when necessary for installation as indicated on the Drawings.
   3. Dampers with damper guards when damper scheduled.
   4. Weather hood when scheduled.
   5. Bird screen: Provide bird screen if no screen is listed on the Fan Schedule.
   6. Finish: Coat fan, housing, and accessories with Hi-Pro Polyester finish.
   7. Diffusers and louvers when scheduled.
   8. Mounting hardware.

2.02 TYPE 5, CENTRIFUGAL CEILING EXHAUST FANS

A. Manufacturers: One of the following or equal:
   1. Greenheck, Model CSP-A or CSP-B, as scheduled.
   2. Cook, Gemini series.
   3. Penn, Zephyr.

B. Characteristics:
   1. Type: Cabinet type centrifugal fan.
   2. Fan: Steel, forward-curved, squirrel-cage type wheel.
   3. Housing: Heavy gauge carbon steel housing.
   4. Access: Removable access panel.

C. Accessories:
   1. Exhaust grille, egg-crate pattern, aluminum, or PVC construction.
   2. Factory installed backdraft damper on discharge of fan.
   3. Finish: Galvanized fan, housing, and damper.

2.03 TYPE 10, CIRCULAR HOOD AXIAL SUPPLY FANS

A. Manufacturers: One of the following or equal:
   1. Greenheck, Model AS.
   2. Loren Cook, similar model.
   3. Penn Ventilator, similar model.

B. Characteristics:
   1. Type: Roof mounted, propeller fan in mushroom shaped housing.
   2. Fan: Direct drive, low pressure, aluminum propeller fan:
      a. Extend a minimum of 8 inches above top of built up roofing.

b. Curb shall be a minimum height of 12 inches.
3. Housing: Mushroom circular aluminum hood with integral roof curb cap.
4. Motor: Permanently lubricated bearings rated for L_{10} life of 200,000 hours; mounted on vibration isolators.
5. Finishes: Provide Hi-Pro Polyester coating over compatible primer on all steel surfaces.

C. Accessories:
1. Provide roof curbs suitable for roof type as indicated on the Drawings.
2. Provide safety screens in roof openings.
3. Provide motorized backdraft damper interlocked with fan motor when backdraft dampers scheduled.

2.04 TYPE 14, CENTRIFUGAL SIDEWALL EXHAUST FANS

A. Manufacturers: One of the following or equal:
1. Greenheck, Model CUBE-WALL.
2. Loren Cook, Model ACWB.
3. Penn Ventilator, similar model.

B. Characteristics:
1. Wall-mounted, upblast circular exhaust fan unit.
2. Backward inclined centrifugal fan wheel with Venturi inlet; performance as scheduled.
3. Materials: Aluminum fan, housing, and accessories.
4. Fan bearings: Permanently lubricated, double shielded, ball bearing type.
5. Adjustable belt drive rated for 150 percent of motor horsepower.
6. Motor characteristics: As scheduled.
7. Finishes: Provide Hi-Pro Polyester coating over compatible primer on all steel surfaces.
8. Provide other accessories as scheduled.

C. Accessories:
1. Mounting brackets: Necessary for installation.
2. Bird screen: Provide bird screen if no screen is listed on the Fan Schedule.

2.05 TYPE 12, FRP BASE MOUNT CENTRIFUGAL FANS (FOR ODOR CONTROL)

A. Manufacturers: One of the following or equal:
1. New York Blower Co.
2. Hartzell Fan.
3. HEE Environmental Engineering, LLC.

B. Characteristics:
1. Fan design/construction: In accordance with ASTM D4167.
2. Fan housing: Solid fiberglass reinforced plastic (FRP).
3. Fan wheel: Backward curved or backward inclined airfoil blades, non-overloading throughout entire curve at rated speed; solid FRP, totally encapsulated aluminum core insert for secure attachment to shaft.
4. Shaft: Ground and polished ASTM A108 grade 1040/1045 steel with Hastelloy sleeve in air stream or Type 316 stainless steel. Shaft to have maximum 1 mil run-out.

5. Bearings: Minimum ABMA L10 life rating of 50,000 hours, grease lubricated with lube tubes extended to outside of housing.
6. Shaft seal: Provide Teflon™ elements in FRP casing, Type 316 stainless steel double lip rings and springs. Extend shaft seal 1/2 inch beyond seal.
7. Duct connections: Provide flanged connections.
8. Drain: Provide 1-inch diameter FRP pipe bonded to a low point in the housing; provide PVC ball valve and threaded plug.
9. Fan inspection port: Provide 8-inch diameter fan housing port to allow examination of interior.
10. Motor and belt cover/guard: Provide FRP, aluminum or Type 316 stainless steel cover over motor and belt drive with louvered side panels to allow motor ventilation sufficient to prevent overheating at 100 percent of full load.
11. Electrical grounding: Coat air stream surfaces with graphite impregnated resin with grounding straps to motor frames or fan base to control static electricity.
12. Abrasive moisture coating: Coat fan wheel with 50 to 60 mil abrasive/erosive resistant coating.
13. Base and bearing support structures: Rigid Structural FRP, aluminum, or Type 316 stainless steel.
14. Duct connection orientation: As indicated on the Drawings.
15. Drive: Belt or direct as scheduled.
16. FRP requirements:
    a. Suitable for continuous operation when exposed to vapors and gases expected to include methane, hydrogen sulfide, chlorine gas, sulfur dioxide, gasoline vapors, ammonia, and water saturated air. Air stream may contain droplets of dilute sulfuric acid, greases, and particulate matter and may vary from 30 degrees Fahrenheit to 130 degrees Fahrenheit.
    b. Housing resin:
        1) Type: Premium polyester resin.
        2) Resin shall achieve Class I flame spread rating below 25 when tested in accordance with ASTM E84 without the use of additives.
        3) Manufacturer: One of the following or equal:
            a) Ashland Chemical Co.
            b) Derakane.
            c) Hetron 92FR; Dow Chemical Co.
    c. Wheel resin:
        1) Type: Premium Vinyl ester resin;
        2) Resin shall achieve Class II flame spread rating below 30 when tested in accordance with ASTM E84.
        3) Manufacturer: One of the following or equal:
            a) Dow Chemical Co.
            b) Derakane 510A40 or 570A40; Ashland Chemical Co.
            c) Hetron.
    d. Protect fiberglass surfaces with minimum 10-mil thickness of ultraviolet resistant resin after initial visual inspections of housing exterior is complete.
    e. Provide Veil-Nexus corrosion resistant surfacing veil and additional coat of fiberglass reinforced plastic resin on surfaces exposed to the air stream for corrosion resistance and chopped strand fiberglass for structural core strength.
17. Balancing: Dynamically balance fan assembly after fabrication and assembly to a maximum of 0.15 inches per second of unbalance at the operating speed.

18. Other accessories:
    a. Vibration isolators: Provide rubber-in-shear type or spring type.
    b. Cover access doors: FRP, neoprene gasket, non-hinged, stainless steel bolts.
    c. Fasteners: Type 316 stainless steel and shall be encapsulated in FRP when exposed to air stream.
    d. Provide other accessories as scheduled. AD6

~~2.05~~2.06 SOURCE QUALITY CONTROL

A. Factory test fans listed on the Fan Schedule for proper operation, performance, and electrical controls.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and verify that Work is in condition to receive installation specified in this Section.

B. Take measurements and verify dimensions to ascertain fit of installation.

C. Ascertain support and openings are correctly located.

3.02 PREPARATION

A. Before installation, remove dust and debris from equipment and ducts.

B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.03 INSTALLATION

A. Observe applicable installation requirements as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Anchoring and support:
    1. Provide anchoring and support for fans and appurtenances.
    2. Provide anchoring to sustain seismic and wind forces as specified in Sections 01612 - Seismic Design Criteria and 01614 - Wind Design Criteria.

C. Adjust alignment of ducts where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

D. Install and wire unit fans and controls in accordance with manufacturer's recommendations.

E. Install flexible connections to fans.

F. Install roof curb and fan as recommended by fan manufacturer.

G. For fan housings with threaded water trap drain, provide drain piped from fan housing to the nearest drain channel, floor drain, or sump.

3.04 FIELD QUALITY CONTROL

A. Test equipment and installation to verify tightness, operation, and unit vibration is within manufacturer's submitted maximum.

B. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.05 COMMISSIONING

A. As specified in Section 01756 - Commissioning, 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Source Testing.
      b. Manufacturer’s Certificate of Installation and Functionality Compliance.
   2. Manufacturer’s Representative onsite requirements:
      a. Installation: 1 trip, 1 day minimum.
      b. Functional Testing: 1 trip, 1 day minimum each.
   3. Training:
      a. Maintenance: 2 hours per session, 2 sessions.
      b. Operation: 1 hour per session, 2 sessions.
   4. Process Operational Period.
      a. As required by Owner or Contractor.

C. Source testing:
   1. Test as specified in Section 15958 - Mechanical Equipment Testing.
   2. Equipment:
      a. Test witnessing: Not witnessed.
      b. Conduct Level 1 General Equipment Performance Test.
      c. Conduct Level 1 Vibration Test.
      d. Conduct Level 1 Noise Test.
      e. Each unit shall be factory tested including control functions and economizer operation prior to shipment.
   3. Electrical Instrumentation and Controls:
      a. Test witnessing: Not witnessed.
      b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

D. Functional testing:
   1. Equipment:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test.
      c. Conduct Level 2 Vibration Test.
      d. Conduct Level 2 Noise Test.
      e. Test equipment and installation to verify tightness, operation, and unit vibration is within manufacturer's submitted maximum.
      f. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.
   2. Electrical Instrumentation and Controls:
      a. Test witnessing: Witnessed.

b. Conduct testing as specified in Section 17100 – Process Instrumentation and Control Systems.

3.06 SCHEDULES

A. Refer to Fan Schedule in the Contract Documents.

END OF SECTION

[AD6] Addendum No. 6

SECTION 15936

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Controls for Heating, Ventilating, and Air Conditioning (HVAC) Systems.

1.02 REFERENCES

A. CSA International (CSA).

B. National Electrical Code (NEC).

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).

D. National Fire Protection Association (NFPA):
   1. 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

E. Underwriters' Laboratories, Inc. (UL):
   1. 268A - Standard for Smoke Detectors for Duct Application.
   2. 508 - Standard for Industrial Control Equipment.
   3. 1479 - Fire Tests of Through-Penetration Firestops.

1.03 DEFINITIONS

A. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 3 enclosure in accordance with NEMA 250.
   3. Type 3R enclosure in accordance with NEMA 250.
   4. Type 4 enclosure in accordance with NEMA 250.
   5. Type 4X enclosure in accordance with NEMA 250.
   6. Type 12 enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. General requirements:
   1. All electrical components shall be UL-listed and meet the design and installation requirements of the NEC.
   2. Complete, functional system: Provide all necessary electrical power and control systems, components, and wiring to make a complete functioning system.
   3. Comply with electrical Sections for electrical power and control systems.
   4. All wiring devices shall be placed in raceways per the requirements of Division 16 specifications.
   5. System control functions to perform as described in Products.
   6. Materials: New, free from defects, and of the quality specified.

7. Common manufacturer: Provide components, component accessories, and devices, as much as possible, by the same manufacturer throughout the work.
8. Mounting: Mount control components and devices in accessible locations for maintenance and as recommended by the manufacturer; provide necessary manufacturer-approved mounting and configuration hardware for mounting and operation of control components and devices.

B. Fire detection system design requirements:
1. Provide all supply and exhaust fans greater than 2,000 cubic feet per minute with a smoke control system including the following minimum components.
a. Fan and air handling unit interlocks interlock to shut down upon smoke detection signal from fire alarm control panel.
b. Field wiring terminal blocks for connection of shut down signals from local fire alarm control panel.

1.05 SUBMITTALS

A. Submit as specified in Section 01300 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings:
1. Manufacturer's information including:
a. Catalog information clearly marked to show specific products, models, and sizes being furnished.
b. Component cut sheets.

1.06 QUALITY ASSURANCE

A. The control system shall be designed in accordance with UL and CSA standards.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The system control products shall be stored and handled per manufacturer's recommendations.

1.08 SITE CONDITIONS

A. Elevation and ambient conditions as specified in Section 01610 - Project Design Criteria.

1.09 WARRANTY

A. Special warranties: Warranty period begins at date of Project Acceptance or first date of Beneficial Use by the Owner:
1. 1 year: Parts and on-site labor for components, systems, and programming.

PART 2 PRODUCTS

2.01 THERMOSTATS

A. General:
   1. Thermostat types: Thermostat types are called out on the drawings by the letter T followed by a number; this designation refers to the specified thermostat types specified in this Section; where no type is called out, provide 1 of the specified types that will match the controlled equipment requirements and provide a functioning system.
   2. Manufacturers: One of the following or equal:
      a. Johnson Controls, model as specified with each type.
      b. Honeywell, Tradeline, equivalent models.

B. T-2, Type 2 Thermostat, Cooling Only, Line Voltage:
   1. Manufacturers: The following or equal: Johnson Controls Model:
      a. Dry locations (no hose bibs or open water processes in room): Model A19BBC-2 in NEMA 1 enclosure.
      b. Wet locations (hose bibs or open water processes in room): Model A19KNC-1 in rain and dust tight enclosure.
   2. Switch action: Single-pole double-throw, close on rising temperature.
   3. Sensing element: Coiled bulb and capillary.
   4. Setpoint: 30 to 110 degrees Fahrenheit with knob adjuster and visible scale.
   5. Electrical ratings: 16 amps alternating current at 120 volts, 9.2 amps alternating current at 208 volts.
   6. Differential range: For dry locations, 3 to 12 degrees Fahrenheit adjustable; for wet locations, 5 degrees Fahrenheit fixed.

2.02 DIFFERENTIAL PRESSURE GAUGES

A. Gauges for local indication of indoor units shall be accurate to within ± 2 percent of full scale.
   1. Gauges shall have 0 adjustment screw and an adjustable set point indicator.
   2. Casing shall be cast aluminum.
   3. Unit shall be able to withstand an overpressure of 15 pounds per square inch gauge.
   4. Each gauge shall be provided with shut-off vent valves each side of the gauge to permit zeroing of the gauge without disconnecting the gauge.
   5. Manufacturers: The following or equal:
      a. Dwyer Magnehelic Series 2000.

2.03 DIFFERENTIAL PRESSURE SWITCHES

A. Differential pressure switches suitable for monitoring pressure drop in non-hazardous spaces:
   1. Manufacturers: One of the following or equal:
      a. Dwyer, Model EDPS series.
      b. Omega.
   2. Characteristics and features:
      a. Service:
         1) Air and other non-combustible, non-aggressive gases.

b. Materials:
    1) Diaphragm: Silicone
    2) Housing: Acetal plastic.
    3) Switch body: PA 6.6.
    4) Cover: Polystyrene.
c. Temperature limits: -4 degrees Fahrenheit to 185 degrees Fahrenheit.
d. Pressure limits: Maximum 40 inches w.c.
e. Switch type: Single-pole double-throw.
f. Electrical rating: 1.5 A, 120 V.
g. Enclosure: NEMA 3.
h. Approvals: ETL approved to UL 508.

2.04 CURRENT SENSORS

A. Provided per specification section 16120.

2.05 DUCT MOUNTED SMOKE DETECTORS

A. General:
    1. Provide duct mounted smoke detectors in air ducting with flows greater than 2,000 cubic feet per minute as indicated on the Drawings.
    2. Capable of mounting to rectangular or round ducts.
    3. Integral filter to reduce dust.
    4. Comply in accordance with UL 268A for air handling systems.
    5. Airflow velocity: 100 to 4,000 feet per minute.
    6. Connect the smoke detector to:
        a. Building fire alarm system.
        b. Fan control circuit to shut down respective fan upon detection of smoke.
        c. Damper control circuits to close respective air dampers to prevent spread of smoke.

B. Non-Classified Areas (SD-1):
    1. Manufacturers: The following or equal:
        a. System Sensor InnovairFlex Series D4120.
    2. Characteristics:
        a. Photoelectric type.
        b. UL 268A listed.
        c. Enclosure: NEMA Type 4.
        d. Operating temperature range of -4 to 158 degrees Fahrenheit.
        e. Power supply voltage: 24 VDC.
        f. Contacts:
            1) Alarm contact: SPST rated for 2 A at 30 VDC.
        g. Auxiliary contacts: DPDT, rated for 10 A at 30 VDC/10 A at 250 VAC.

C. Accessories:
    1. Provide metal sampling tube and end cap to match duct width. Sampling tube shall be able to be installed without use of tools.
    2. Provide mounting base and hardware.
    3. Provide duct access door as specified in Section 15812 - Metal Ducts. Provide similar for non-metallic ducting.
    4. Provide remote annunciator with alarm and power LEDs and all required wiring and conduit per installation instructions for complete working operation.

5. Provide remote test station and all required wiring and conduit per installation instructions for complete working operation.

2.06 HVAC CONTROL DESCRIPTIONS

A. General: Provide control systems that will maintain room or area comfort under changing ambient conditions and varying use; descriptions in this Section are general in nature and do not cover every mode of operation.

B. Influent Lift Station (Area 10)
   1. Influent Lift Station Vault Control Sequences
      a. Supply Fan LS-WW1-VF-01 shall run continuously and provide 100% outside air to the Influent Lift Station Vault.
      b. The Fan shall have a Current Sensor provided at the MCC.
      c. Status/Alarms:
         1) A “Running” status shall be displayed at SCADA when the fan is running.
         2) A “General HVAC Fail” alarm shall be displayed at SCADA when the fan is de-energized.

C. Headworks Building (Area 20)
   1. Headworks Building Screenings Room Control Sequences
      a. Supply Fan HW-BLDG1-VF-01 shall run continuously and provide 100% outside air to the Screenings Room.
      b. The Fan shall have a Current Sensor provided at the MCC.
      c. Status/Alarms:
         1) A “Running” status shall be displayed at SCADA when the fan is running.
         2) A “General HVAC Fail” alarm shall be displayed at SCADA when the fan is deenergized.
      d. Electric Unit Heaters HW-BLDG1-UH-01, HW-BLDG1-UH-02, HW-BLDG1-UH-03, HW-BLDG1-UH-04, and HW-BLDG1-UH-05 will be controlled by manufacturer integral thermostats with adjustable set-points.
         1) The heating set-point will be 55 degrees Fahrenheit. When the temperature falls 5 degrees below the set-point, the units will energize. When the temperature rises 5 degrees above the set point, the units will de-energize.

D. Electrical Service Station No. 1 (Area 85)
   1. Electrical Room and HVAC Room Control Sequences
      a. Split System Heat Pump Units, SUB1-HVAC-02/SUB1-HVAC-01 and SUB1-HVAC-04/SUB1-HVAC-03 will be controlled by manufacturer provided thermostat(s) with adjustable set points in a lead/lag configuration.
         1) The cooling set-point for the lead unit will be 75 degrees Fahrenheit and 80 degrees Fahrenheit for the lag unit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature drops to 5 degrees below the setpoint the units will de-energize.

2) The heating set-point for the lead unit will be 65 degrees Fahrenheit and 60 degrees Fahrenheit for the lag unit. When the temperature falls 5 degrees below the heating set-point, the units will energize. When the temperature rises to 5 degrees above the setpoint the units will de-energize.
3) The lead/lag designations of the units should be rotated periodically to allow equal wear.
4) Status/Alarms:
a. SUB1-HVAC-02 and SUB1-HVAC-04 shall each have a differential pressure switch. When the switch indicates high pressure, a “Dirty Filter” alarm shall display at SCADA.
b. SUB1-HVAC-02 and SUB1-HVAC-04 shall each have a duct mounted smoke detector. When the detector senses smoke, the FACP shall shut down the HVAC system. A “Smoke” alarm will be sent from the FACP to the PLC and SCADA shall display the “Smoke Alarm”
c. SUB1-HVAC-02 and SUB1-HVAC-04 will send a “General HVAC Fail” alarm to the SCADA system upon unit de-energizing.
d. SUB1-HVAC-02 and SUB1-HVAC-04 shall each be provided with a condensate monitoring switch at the condensate drain pan. When the switch indicates high condensate, a “High Condensate” alarm shall display at SCADA.

2. Positive Pressurization Units (PPU) SUB1-HVAC-05 and SUB1-HVAC-06 shall run continuously and recirculate filtered air throughout the space.
a. The PPUs shall be monitored and provide the following to SCADA:
1. A “Running status shall be displayed at SCADA when the PPU is running.
2. A “General HVAC Fail” alarm shall be displayed at SCADA when the PPU is deenergized.
3. A “Dirty Filter” alarm shall be displayed at SCADA when the differential pressure switch indicates high pressure.

3. One RTD will be provided for this room by electrical contractor. The RTD will provide real time temperature of the room. The information will be sent to the PLC.

E. Administration Building (Area 90)
1. IT/SCADA Server Room Control Sequences
a. Mini-Split Heat Pump Systems, AD-HVAC-08/AD-HVAC-01 and AD-HVAC-09/AD-HVAC-02 will be controlled by manufacturer provided thermostat(s) with adjustable set-points in a lead/lag configuration.
1) The cooling set-point for the lead unit will be 75 degrees Fahrenheit and 80 degrees Fahrenheit for the lag unit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature drops to 5 degrees below the setpoint the units will de-energize.
2) The heating set-point for the lead unit will be 65 degrees Fahrenheit and 60 degrees Fahrenheit for the lag unit. When the temperature falls 5 degrees below the heating set-point, the units will energize. When the temperature rises to 5 degrees above the setpoint the units will de-energize.

3) The lead/lag designations of the units should be rotated periodically to allow equal wear.

b. Positive Pressurization Unit (PPU) AD-HVAC-10 shall run continuously and recirculate filtered air throughout the space.
   a. The PPU shall be monitored and provide the following to SCADA:
      1) A “Running status shall be displayed at SCADA when the PPU is running.
      2) A “General HVAC Fail” alarm shall be displayed at SCADA when the PPU is deenergized.
      3) A “Dirty Filter” alarm shall be displayed at SCADA when the differential pressure switch indicates high pressure.

c. One RTD will be provided for this room by electrical contractor. The RTD will provide real time temperature of the room. The information will be sent to the PLC.

2. UV Panels Room Control Sequences
   a. Mini-Split Heat Pump Systems, AD-HVAC-11/AD-HVAC-06 and AD-HVAC-12/AD-HVAC-07 will be controlled by manufacturer provided thermostat(s) with adjustable set-points in a lead/lag configuration.
      1) The cooling set-point for the lead unit will be 75 degrees Fahrenheit and 80 degrees Fahrenheit for the lag unit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature drops to 5 degrees below the setpoint the units will de-energize.
      2) The heating set-point for the lead unit will be 65 degrees Fahrenheit and 60 degrees Fahrenheit for the lag unit. When the temperature falls 5 degrees below the heating set-point, the units will energize. When the temperature rises to 5 degrees above the setpoint the units will de-energize.
      3) The lead/lag designations of the units should be rotated periodically to allow equal wear.
   b. One RTD will be provided for this room by electrical contractor. The RTD will provide real time temperature of the room. The information will be sent to the PLC.
3. Restroom/Shower Control Sequences
   a. Exhaust Fan AD-BLDG1-EF-02 will be interlocked with the lights of the restroom. When the lights are turned on, the fan will energize. When the lights are turned off, the fan will de-energize.
4. Restroom/Shower Control Sequences
   a. Exhaust Fan AD-BLDG1-EF-03 will be interlocked with the lights of the restroom. When the lights are turned on, the fan will energize. When the lights are turned off, the fan will de-energize.
5. Custodian Room Control Sequences
   a. Exhaust Fan AD-BLDG1-EF-04 will be interlocked with the lights of the restroom. When the lights are turned on, the fan will energize. When the lights are turned off, the fan will de-energize.
6. Administration Office Space (Lower Level) Control Sequences
   a. Split System Heat Pump Unit, AD-HVAC-13/AD-HVAC-03 will be controlled by a manufacturer provided thermostat with adjustable set-points.

1) The cooling set point will be 75 degrees Fahrenheit. When the temperature rises 5 degrees above the cooling set point, the unit will energize. When the temperature drops 5 degrees below the set point, the unit will de-energize.
2) The heating set point will be 65 degrees Fahrenheit. When the temperature drops 5 degrees below the heating set point, the unit will energize. When the temperature rises 5 degrees above the heating set point, the unit will de-energize.
3) Status/Alarms:
e. AD-HVAC-13 shall have a differential pressure switch. When the switch indicates high pressure, a “Dirty Filter” alarm shall display at SCADA.
f. AD-HVAC-13 shall have a duct mounted smoke detector. . When the detector senses smoke, the FACP shall shut down the HVAC system. A “Smoke” alarm will be sent from the FACP to the PLC and SCADA shall display the “Smoke Alarm”
g. AD-HVAC-13 will send a “General HVAC Fail” alarm to the SCADA system upon unit de-energizing.
h. AD-HVAC-13 shall be provided with a condensate monitoring switch at the condensate drain pan. When the switch indicates high condensate, a “High Condensate” alarm shall display at SCADA.

b. One RTD will be provided for this room by electrical contractor. The RTD will provide real time temperature of the room. The information will be sent to the PLC.

7. Electrical Room Control Sequences
a. Split System Heat Pump Units, AD-HVAC-14/AD-HVAC-04 and AD-HVAC-15/AD-HVAC-05 will be controlled by manufacturer provided thermostat(s) with adjustable set-points in a lead/lag configuration.
1) The cooling set-point for the lead unit will be 75 degrees Fahrenheit and 80 degrees Fahrenheit for the lag unit. When the temperature rises 5 degrees above the cooling set point, the units will energize. When the temperature drops to 5 degrees below the setpoint the units will de-energize.
2) The heating set-point for the lead unit will be 65 degrees Fahrenheit and 60 degrees Fahrenheit for the lag unit. When the temperature falls 5 degrees below the heating set-point, the units will energize. When the temperature rises to 5 degrees above the setpoint the units will de-energize.
3) The lead/lag designations of the units should be rotated periodically to allow equal wear.
4) Status/Alarms:
i. AD-HVAC-14 and AD-HVAC-15 shall each have a differential pressure switch. When the switch indicates high pressure, a “Dirty Filter” alarm shall display at SCADA.
j. AD-HVAC-14 and AD-HVAC-15 shall each have a duct mounted smoke detector. When the detector senses smoke, the FACP shall shut down the HVAC system. A “Smoke” alarm will be sent from the FACP to the PLC and SCADA shall display the “Smoke Alarm”
k. AD-HVAC-14 and AD-HVAC-15 will send a “General HVAC Fail” alarm to the SCADA system upon unit de-energizing.

l. AD-HVAC-14 and AD-HVAC-15 shall each be provided with a condensate monitoring switch at the condensate drain pan. When the switch indicates high condensate, a “High Condensate” alarm shall display at SCADA.

b. Positive Pressurization Unit (PPU) AD-HVAC-16 shall run continuously and recirculate filtered air throughout the space.
   1) The PPU shall be monitored and provide the following to SCADA:
   2) A “Running status shall be displayed at SCADA when the PPU is running.
   3) A “General HVAC Fail” alarm shall be displayed at SCADA when the PPU is deenergized.
   4) A “Dirty Filter” alarm shall be displayed at SCADA when the differential pressure switch indicates high pressure.

c. One RTD will be provided for this room by electrical contractor. The RTD will provide real time temperature of the room. The information will be sent to the PLC.

8. Open Area/Mezzanine Control Sequences
   a. Exhaust Fan AD-BLDG1-EF-01 shall be controlled by a Thermostat (Type T-2) with adjustable setpoint.
   b. The Fan shall be provided with a Duct Mounted Smoke Detector.
   c. The Fan shall have a Current Sensor provided at the MCC.
   d. Status/Alarms:
      1) A “Running” status shall be displayed at SCADA when the fan is running.
      2) A “Low Flow Alarm” shall be displayed at SCADA when the Current Sensor indicates a flow of 10% or more below the operating flow.
      3) A “General HVAC Fail” alarm shall be displayed at SCADA when the fan is deenergized.
      4) When the detector senses smoke, the FACP shall shut down the HVAC system. A “Smoke” alarm will be sent from the FACP to the PLC and SCADA shall display the “Smoke Alarm”
   e. Electric Unit Heaters AD-BLDG1-UH-01, AD-BLDG1-UH-02, AD-BLDG1-UH-03, AD-BLDG1-UH-04, AD-BLDG1-UH-05, and AD-BLDG1-UH-06 will be controlled by manufacturer provided thermostats with adjustable set-points.
      1) The heating set-point will be 55 degrees Fahrenheit. When the temperature falls 5 degrees below the set-point, the units will energize. When the temperature rises 5 degrees above the set point, the units will de-energize.

PART 3 EXECUTION

3.01 PREPARATION

A. Before installation remove dust and debris from equipment and accessories.

B. During installation and until equipment is operated, protect equipment and accessories from dust and debris.

3.02 INSTALLATION

A. Install as indicated on the Drawings, in accordance with NFPA 90A, and per the manufacturer's written instructions.

B. Coordinate installation of HVAC control systems with other trades.
   1. Prior to installation, coordinate wiring and conduit requirements with electrical subcontractor.

C. Mount remote annunciator and test station on wall near smoke detector.
   1. Devices shall be easily accessible from floor level.
   2. Label annunciator and test station.

D. Provide all electrical work to support smoke detector.
   1. Coordinate with electrical subcontractor.

E. Sensor and control station mounting:
   1. Where not otherwise indicated, mount 5 feet above floor or walking level.
   2. Provide insulating back plates when mounting is on an exterior wall or a wall adjoining an unconditioned space.
   3. Shield outside thermostats or sensors from the sun; provide thermostats with remote bulb and compensated capillary.
   4. Install locking covers where indicated on the Drawings.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Functional testing:
   1. HVAC Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Test each control component and system as part of HVAC system testing, adjusting, and balancing as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 15954

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Heating, ventilation, and air conditioning systems testing, adjusting, and balancing.

1.02 REFERENCES

A. Associated Air Balance Council (AABC):
   1. National Standards for Field Measurements and Instrumentation, Total System Balance, Air Distribution Systems.

B. National Environmental Balancing Bureau (NEBB):
   1. Procedural Standards for Testing, Adjusting, and Balancing Environmental Systems.

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. Heating, Ventilating, and Air Conditioning Systems - Testing, Adjusting, and Balancing.

D. Testing, Adjusting, and Balancing Bureau (TABB):
   1. International Standards for Environmental Systems Balance.

1.03 TESTING, ADJUSTING, AND BALANCING WORK REQUIREMENTS

A. Procure the services of an independent air balance and testing agency belonging to and in good standing with the AABC, NEBB, or the TABB to perform air balancing, testing, and adjustment of building and process air conditioning, heating, and ventilating air systems.

B. The Work includes: Balancing new air systems installed as part of this contract and existing air systems affected by the installation of new equipment.

C. Perform testing of heating, ventilating, and air conditioning equipment, balancing of distribution systems, and adjusting of air terminal units and ductwork accessories to ensure compliance with Specifications and Drawings. Perform tests for following:
   1. Heat pump units.
   2. Heating units.
   3. Fans.
   4. Ductwork accessories.
   5. Ducting.
   6. HVAC controls.
   7. Other specified HVAC equipment.

D. Test each mode of operation of thermostats, electronic controllers, and pneumatic, electric or electronic heating, ventilating, and air conditioning instruments to ensure operation as specified.

E. Test and adjust room distribution patterns at air outlets.

F. Provide instruments required for testing, adjusting, and balancing operations; retain possession of instruments; remove instruments from site at completion of services.

G. Make instruments available to the Engineer to facilitate spot checks during testing.

H. Provide test holes for pressure and pitot flow measurements; provide plugs for all test holes after testing.

1.04 QUALITY ASSURANCE

A. Test, balance, and adjust environmental systems in accordance with either:
   1. AABC: National Standards for Field Measurements and Instrumentation, Total Systems Balance.
   2. NEBB: Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
   3. TABB: International Standards for Environmental Systems Balance.

B. Perform services under direction of AABC, NEBB, or TABB certified supervisor.

C. Calibrate and maintain instruments in accordance with requirements of standards. Make calibration histories of instruments available for examination.

D. Make measurements in accordance with accuracy requirements of standards.

E. Testing, adjusting, and balancing performance requirements:
   1. Comply with procedural standards of certifying association.
   2. Execute each step of prescribed testing, balancing, and adjusting procedures without omission.
   3. Accurately record required data.
   4. Make measurements in accordance with recognized procedures and practices of certifying association.
   5. Measure air volume discharged at each outlet and adjust air outlets to design air volumes within 5 percent over.

1.05 SUBMITTALS

A. Resumes of proposed supervisor and personnel showing training and qualifications.

B. Interim reports: At least 30 days prior to starting field work, submit the following:
   1. Set of report forms filled out as to design flow values and installed equipment pressure drops, and required cubic feet per minute for air terminals.
   2. Develop heating, ventilating, and air conditioning system schematic similar to Figure 6-1 in SMACNA Testing, Adjusting, and Balancing.
   3. Complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each showing:
      a. Manufacturer and model number.
      b. Description and use when needed to further identify instrument.

c. Size or capacity range.
d. Latest calibration date.

C. Final report: At least 15 days prior to Contractor's request for final inspection, submit 3 copies of final reports, on applicable reporting forms. Include:
1. Identify instruments which were used and last date of calibration of each.
2. Procedures followed to perform testing, adjusting, and balancing.
3. Identification and succinct description of systems included in report.
4. Initial balance test results made with all dampers and air control devices in full open positions.
5. Description of final locations and sizes, including opening area and dimensioned configuration of orifices and other restrictions used to achieve final balanced flows.
6. Description of final location and opening positions of dampers, registers, louvers, and valves.
7. Schematics of systems included in report; use schematics as part of testing, adjusting, and balancing report to summarize design and final balanced flows.
8. Testing, adjusting, and balancing report forms.
9. Final field results established for system balancing including airflow, fan speeds, and fan static pressures at the fan inlet and outlet.
10. Appendices.
11. Include appendices for:
a. Raw field data taken during testing.
b. Sample calculation sheet for each type of calculation made to convert raw field data to final results.
c. Initial air balance results with dampers and registers in full open position; include airflow at all inlets and outlet, initial fan speed and fan suction and discharge pressures.

D. Proposed schedule for testing and balancing.

E. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.06 SITE CONDITIONS

A. Prior to start of testing, adjusting, and balancing, verify that:
1. Systems installation is complete and in full operation.
2. Outside conditions are within reasonable range relative to design conditions.
3. Lighting fixtures are energized.
4. Special equipment such as computers, laboratory equipment, and electronic equipment are in full operation.
5. Requirements for preparation for testing and balancing have been met for elements of each system which require testing.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Perform Functional Tests as specified in Section 01756 - Commissioning.

B. Testing, adjusting, and balancing acceptance criteria: Consider testing, adjusting, and balancing procedures successful and complete when heating, ventilating, and air conditioning systems and components are functioning properly and system air flows are within specified tolerances of design flows.

3.02 TESTING, ADJUSTING, AND BALANCING

A. Test, adjust, and balance separate complete heating, ventilating, and air conditioning systems.

B. Include in testing, adjusting, and balancing related existing heating, ventilating, and air conditioning components.

C. Perform testing, adjusting, and balancing cycles until airflows meet acceptance criteria.
   1. Ascertain airflow balance between overall requirements and flow in individual supply and exhaust grilles.

D. Initial testing, adjusting, and balancing: Perform first test on each system with dampers, grilles, orifices, and other variable airflow devices in their full open position; measure and report initial airflows, fan speed, and fan static pressures at fan inlet and outlet.
   1. Adjust total system flow downward or upward by adjusting fan speed until 1 inlet or outlet is at indicated flow and all other flows exceed indicated flows.
   2. Adjust fan speed by changing fan drives or sheaves as necessary.

E. Subsequent testing, adjusting, and balancing: Perform adjustments in subsequent testing, adjusting, and balancing by adjusting dampers, louvers, or size of orifices or plates.
   1. Measure and record air volume discharged at each inlet and outlet and adjust air inlets and outlets to design air volumes within 0 to 5 percent over design rates.
   2. Adjust fan speeds and motor drives within drive limitations, for required air volume.
   3. Measure cubic feet per minute and static pressures and adjust air supply and exhaust fan units to deliver at least 100 to 105 percent of the design air volume.
   4. Measure and record static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.
   5. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
   6. Evaluate space and zone temperature of conditions to determine adequate performance of the systems to maintain temperatures without draft.
   7. Permanently mark final balance positions of balancing dampers.

F. Develop heating, ventilating, and air conditioning system schematics similar to Figure 6-1 in SMACNA Testing, Adjusting, and Balancing.

G. Accurately record the required data on AABC, NEBB, or TABB test and balance report forms.

H. Measure amperage draw of fan and pump motors for final balance.

I. Test primary source equipment in accordance with AABC, NEBB, or TABB procedures.
   1. Primary source equipment includes items listed in this Section not previously tested as part of this testing, adjusting, and balancing work.
   2. Complete appropriate AABC, NEBB, or TABB equipment test forms for each piece of equipment.
   3. Calculate cooling and heating capacities to show conformance with specified capacities.
   4. Adjust equipment as needed to deliver specified cooling and heating loads.
   5. Record final equipment performing characteristics and adjustment settings in the final design report.

END OF SECTION

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SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Test requirements for piping systems.

1.02 REFERENCES

A. National Fuel Gas Code (NFGC).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.3 - Process Piping.
   3. B31.8 - Gas Transmission and Distribution Piping Systems.

C. Underwriters Laboratories Inc. (UL).

1.03 TESTING REQUIREMENTS

A. General requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052 - Common Work Results for General Piping; are specified in the specifications covering the various types of piping; and are specified in this Section.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01410 - Regulatory Requirements, and UL requirements.
   4. Test natural gas or digester gas piping:
      a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01410 - Regulatory Requirements, or the National Fuel Gas Code, whichever is more stringent.
      b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
   5. When testing with water, the specified test pressure is considered to be the pressure at the lowest point of the piping section under test.
      a. Lower test pressure as necessary (based on elevation) if testing is performed at higher point of the pipe section.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01500 - Temporary Facilities and Controls.

D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test completion: Drain and leave piping clean after successful testing.

G. Test water disposal: Dispose of testing water in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site, and as approved by the Owner.

1.04 SUBMITTALS

A. Submit as specified in Section 01300 - Submittals.

B. Schedule and notification of tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of readiness to test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping.
   3. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection test:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within 1 percent plus or minus.
   4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.02 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
   1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 15052 - Common Work Results for General Piping:
   1. Provide temporary pressure relief valve for piping under test:
      a. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
   2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASME B31.3, ASE B31.8, or the pipe manufacturer's stated maximum working pressure.
   3. Gradually increase test pressure to an initial test pressure equal to the lesser of 1/2 the test pressure or 25 pounds per square inch gauge.
   4. Perform initial check of joints and fittings for leakage.
   5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage; at each step increase until test pressure reached.
   6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
   7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.03 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with "GR" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.
      b. For plastic piping test for deflection.
      c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
   2. Inspect piping for visible leaks before backfilling.
   3. Provide temporary restraints when needed to prevent movement of piping.
   4. Pressure test piping with maximum leakage allowance after backfilling.
   5. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours:
      a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
      b. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
      c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of 4 hours while accurately measuring the volume of water added to maintain the test pressure:
         1) Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
            a) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test:
               (1) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
            b) For vitrified clay piping: 500 gallons per day per inch of diameter per mile of piping under test.
            c) For other piping: 80 gallons per day per inch diameter per mile of piping under test.

3.04 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment, or piping specialty safe test pressure allowed by the item's manufacturer.

4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
6. When test results indicate failure of selected sections, limit tests to piping:
   a. Between valves.
   b. Between a valve and the end of the piping.
   c. Less than 500 feet long.
7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing procedures:
1. Fill piping section under test slowly with water while venting air:
   a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
3. Raise pressure to the specified test pressure and inspect piping visually for leaks:
   a. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
2. Pressure test piping after completion of visible leaks test.
3. For piping systems using joint designs other than flanged, threaded, or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
   b. Successful completion of the pressure test with maximum leakage allowance shall be achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
   c. When leakage is allowed, calculate the allowable leakage by the following formula:

      $L = S \times D \times P^{1/2} \times 133{,}200^{-1}$

      wherein the terms shall mean:

      L = Allowable leakage in gallons per hour.

      S = Length of the test section in feet.

      D = Nominal diameter of the piping in inches.

      P = Average observed test pressure in pounds per square inches gauge, at the lowest point of the test section, corrected for elevation of the

pressure gauge.

x = The multiplication symbol.

3.05 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. General:
   1. Test pressures shall be as scheduled in Section 15052 - Common Work Results for General Piping.
   2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
   3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
   4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible leaks test:
   1. Subject piping under test to specified pressure measured at the lowest end.
   2. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
   4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Pressure test piping after completion of visible leaks test.
   2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours, and no damage to piping and appurtenances has occurred.
      b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

E. Optional joint test:
   1. When joint testing is allowed by note in the Piping Schedule, the procedure shall be as follows:
      a. Joint testing will be allowed only for low head pressure piping.
      b. Joint testing does not replace and is not in lieu of any testing of the piping system or trust restraints.
   2. Joint testing may be performed with water or air.
   3. Joint test piping after completion of backfill and compaction to the top of the trench.

4. Joint testing with water:
    a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
    b. Maintain test pressure for 1 minute.
    c. Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
    d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
    e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
5. Joint testing with air:
    a. Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
    b. Maintain test pressure for 2 minutes.
    c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION

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SECTION 15958

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

C. National Institute of Standards and Technology (NIST).

1.03 SUBMITTALS

A. Provide Source Test Plans as specified in Section 01756 - Commissioning.

B. Provide Installation and Functional Testing Plans as specified in Section 01756 - Commissioning.

C. Provide vendor operation and maintenance manual as specified in Section 01730 - Operation and Maintenance Manuals.
   1. Include motor rotor bar pass frequencies for motors larger than 500 horsepower.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL

A. Commissioning of equipment as specified in:
   1. This Section.
   2. Section 01756 - Commissioning.
   3. Equipment sections:
      a. If testing requirements are not specified, provide Level 1 Tests.

B. Test and prepare piping as specified in Section 15956 - Piping Systems Testing.

C. Operation of related existing equipment:
   1. Owner will operate related existing equipment or facilities necessary to accomplish the testing.

2. Schedule and coordinate testing as required by Section 01756 - Commissioning.

D. Provide necessary test instrumentation that has been calibrated within 1 year from date of test to recognized test standards traceable to the NIST or approved source.
   1. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for tests.
   2. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

E. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments.
      a. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy.
      a. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

3.02 VARIABLE SPEED EQUIPMENT TESTS

A. Establish performance over the entire speed range and at the average operating condition.

B. Establish performance curves for the following speeds:
   1. The speed corresponding to the rated maximum capacity.
   2. The speed corresponding to the minimum capacity.
   3. The speed corresponding to the average operating conditions.

3.03 PUMP TESTS, ALL LEVELS OF TESTING

A. Test in accordance with the following:
   1. Applicable HI Standards.
   2. This Section.
   3. Equipment sections.

B. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
   1. From 0 to plus 5 percent of head at the specified flows rated design point flow.
   2. From 0 to plus 5 percent of flow at the rated design point head.
   3. No negative tolerance for the efficiency at the specified flows rated design point.
   4. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

3.04 DRIVERS TESTS

A. Test motors as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.

B. Test other drivers as specified in the equipment section.

3.05 NOISE REQUIREMENTS AND CONTROL

A. Perform noise tests in conjunction with vibration test analysis.

B. Make measurements in relation to reference pressure of 0.0002 microbar.

C. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

D. Set sound level meter to slow response.

E. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.06 PRESSURE TESTING

A. Hydrostatically pressure test pressure containing parts at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher.

3.07 INSPECTION AND BALANCING

A. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits.

B. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.

C. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

D. Critical speed of rotating equipment:
   1. Satisfy the following:
      a. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment’s maximum operating speed.
      b. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment’s lowest operating speed.
      c. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

E. Vibration tests:
   1. Definitions:
      a. Root mean square: for pumps operating at speeds greater than 600 rpm, the vibration measurement shall be measured as the overall velocity in inches per second root mean square (RMS).
      b. Peak-to-peak displacement: The root means squared average of the peak-to-peak displacement multiplied by the square root of 2.
      c. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
      d. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
      e. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
         1) Manufacturers: One of the following or equal:
            a) Rockwell Automation, Entek Group, "Spike Energy" analysis.
            b) CSI, "PeakVue."
      f. Rotor bar pass frequency (RBF), for detecting loose rotor bars.
      g. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
      h. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.
      i. Preferred operating range: Manufacturer’s defined preferred operating range (POR) for the equipment.
      j. Allowable operating range: Manufacturer’s defined allowable operating range (AOR) for the equipment.
   2. Vibration instrumentation requirements:
      a. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12-bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high-frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
         1) Manufacturers: One of the following or equal:
            a) Computational Systems Inc., (CSI) Division of Emerson Process Management, Model 2120A, Data Collector/analyzer with applicable analysis software.
            b) Pruftechnik, VIBXPERT II.
      b. Analyzer settings:
         1) Units: English, inches/second, mils, and gravitational forces.
         2) Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
         3) Sample averages: 4 minimum.
         4) Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.

5) Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
6) Fast fourier transform windowing: Hanning Window.
7) High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

c. Accelerometers:
1) For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
a) Manufacturers: One of the following or equal:
(1) Wilcoxon Research, Model 797L.
(2) PCB, Model 393C.
2) For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.
a) Manufacturers: One of the following or equal:
(1) Wilcoxon Research, Model 793.
(2) Entek-IRD Model 943.

3. Accelerometer mounting:
a. Use magnetic mounting or stud mounting.
b. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
c. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.

4. Vibration acceptance criteria:
a. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.
b. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Conditions and Application Data	Overall Peak-to-Peak Displacement	
	Field, mils	Factory, mils
Operation within the POR	3.0	4.0
Operation within the AOR	4.0	5.0
Additive value when measurement location is greater than 5 feet above foundation.	2.0	2.0
Additive value for solids-handling pumps	2.0	N/A
Additive value for slurry pumps	2.0	N/A

c. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Horizontal Solids Handling Centrifugal Pumps	Below 33 hp	0.25	0.28
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type)	Between 33 and 100 hp	0.28	0.31
	100 hp and above	0.31	0.34
Vertical Solids Handling Centrifugal Pumps	Below 33 hp	0.30	0.33
Vertical Turbine, Mixed Flow, and Propeller Pumps (solids-handling type pumps)	Between 33 and 100 hp	0.32	0.35
	100 hp and above	0.34	0.35
Non-Solids Handling Centrifugal Pumps HI Types BB1, BB2, BB3, BB4, BB5, OH1, OH2, OH3, OH4, OH5, and OH7	Below 268 hp	0.15	0.19
	268 hp and above	0.19	0.22
Vertical Turbine, Mixed Flow, and Propeller Pumps HI Types VS1, VS2, VS3, VS4, VS5, VS6, VS7, and VS8	Below 268 hp	0.13	
	268 hp and above	0.17	
Slurry Pumps		0.25	0.30
Motors		See Applicable Motor Specification	See Applicable Motor Specification
Gear Reducers, Radial		Not to exceed AGMA 6000-B96 limits	Not to exceed AGMA 6000-B96 limits
Other Reducers, Axial		0.1	N/A

d. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

e. Additional criteria:
   1) No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
   2) The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.

3) For motors, the following shall be cause for rejection:
   a) Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that is more than 40 percent of the peak at rotational frequency.
   b) Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.
   c) Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
   d) Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.
4) The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

5. Vibration testing results presentation:
   a. Provide equipment drawing with location and orientation of measurement points indicated.
   b. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
   c. When Vibration Spectra Data required:
      1) Plot peak vibration velocity versus frequency in cycles per minute.
      2) Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
      3) Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
      4) Plot motor spectra on a log amplitude scale versus frequency.
   d. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
   e. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.08 TESTING LEVELS

A. Level 1 Tests:
   1. Level 1 General Equipment Performance Test:
      a. For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
      b. Operate at rated design load conditions.

c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

2. Level 1 Pump Performance Test:
   a. Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower or the applicable equipment section. Use actual driver for field tests.
   c. Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
3. Level 1 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Test at specified maximum speed.
4. Level 1 Noise Test:
   a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Tests:
1. Level 2 General Performance Test:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions.
   c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
2. Level 2 Pump Performance Test:
   a. Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower. Use actual driver for field tests.

c. Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
d. Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.

3. Level 2 Vibration Test:
   a. Test requirement:
      1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
      2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
   c. Natural frequency test of field installed equipment:
      1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears, and supports.
      2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
      3) Perform with equipment and attached piping full of intended service or process fluid.
4. Level 2 Noise Test:
   a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Tests:
1. Level 3 General Equipment Performance Tests:
   a. For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
   c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration, or temperatures are observed.
   d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure, and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
   e. Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 3 Pump Performance Test:
    a. Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
    b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower. Use actual driver for field tests.
    c. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
    d. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
3. Level 3 Vibration Test:
    a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
    b. Perform High Frequency Enveloping Analysis for gears and bearings.
        1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
        2) Report results in units of acceleration versus frequency in cycles per minute.
    c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
    d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
4. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plain view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Tests:
1. Level 4 General Equipment Performance Test:
    a. For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
    b. Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
    c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration, or temperatures are observed.

d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings, using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
e. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 4 Pump Performance Test:
   a. Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
   b. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
   c. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
   d. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
   e. Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
      1) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
      2) Perform efficiency testing with test fluids at maximum rated speed.
      3) Perform priming time testing with test fluids at maximum rated speed.
3. Level 4 Vibration Test: Same as Level 3 vibration test.
4. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

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SECTION 16120

480 VOLT MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Scope of Work
   1. The Contractor shall furnish and install the motor control centers and metal enclosed overhead bus duct as specified herein and as shown on the PLANS.
   2. Where bus duct is required by the PLANS, the Contractor shall furnish and install the bus duct system including all necessary fittings, hangers, and accessories as specified herein and as shown on the PLANS.

1.02 RELATED WORK NOT INCLUDED

A. The PLANS designate the type, number, size and rating of devices included in the Motor Control Centers (MCCs)

B. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 QUALIFICATIONS

A. The manufacturer of the MCCs shall also manufacture the majority of components and subsystems therein (i.e., circuit breakers, starters, controls relays, etc.)

B. The MCCs shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, UL, and NEC standards.

C. MCCs shall be as manufactured by Square D Company, Eaton Cutler-Hammer Corporation, Allen-Bradley, Asea Brown Boveri, or approved equal.

1.04 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:
   1. Dimensioned/scaled top and bottom views, front elevations, and internal component/device layouts
   2. One-line diagrams and wiring diagrams,
   3. Catalog cut sheets. Include protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable.
   4. Key interlock scheme drawing and sequence of operations, where applicable.
   5. Overhead bus duct support details and support recommendations.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:
   1. Installation and operation manuals.
   2. Renewal parts bulletin.
   3. As built drawings, including approved shop drawings.
   4. Test data.
   5. Sealed and signed arc flash hazard analysis, harmonic study, motor starting, short circuit, and coordination study report. Report to include all final setpoints used.

B. Additional information as required by subsection 1.08, this section of the Specifications.

1.06 STORAGE AND HANDLING

A. Protection
   1. The Contractor, and hence the MCC supplier, shall be responsible for safety of the MCC during storage, transporting and handling.
   2. The MCC shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
   3. At all times the MCC shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   4. Interior and exterior of MCC shall be kept clean at all times.
   5. Energize the space heaters within the MCC and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following
   1. Environmentally protected and stored in climate controlled (temperature, humidity, and non-corrosive class) environment at the job site. Size, furnish and install temporary gaseous air scrubbers, air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
   2. Ambient Dry Bulb Temperature:
   3. Minimum: 68 degrees Fahrenheit
   4. Maximum: 85 degrees Fahrenheit
   5. Ambient Relative Humidity: Maximum: 50%.
   6. Ambient Corrosion Level: International Society of Automation Class: G1
   7. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
   8. Upon arrival of equipment onto job site, a maximum of one day shall be allowed for equipment to be left without to allow proper transition of power of equipment, especially any 120 VAC powered equipment, to ensure all air conditioning, heating, and gaseous air scrubbing equipment are fully operational with a maximum of a 10 minute down time during this transition of power.
   9. Furnish and install replacement air scrubber media, air filters, etc., as required for proper operation of the environmental control equipment.

1.07 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each MCC in conformance with the specifications:
   1. One (1) – Set of fuses (minimum 3) for each type and size used.
   2. One (1) – Set of starter contacts for every three (3) like starters used (a minimum of 1 for each size used). If contacts are not replaceable a spare starter for each size used shall be supplied.
   3. Two (2) - Contactor coils for every NEMA size and type starter installed, a minimum of one coil per size.
   4. Two (2) - Spare control relays for each type used. Control relay shall be furnished complete with relay coils, Four (4) Normally Open (N.O.) contacts, Four (4) Normally Closed (N.C.) contacts, and shall be furnished with Relay Manufacturer's Transient Voltage Suppression Module.
   5. One (1) - Spare timing relay.
   6. Two (2) – Sets of overload heaters for each size and type used.
   7. One (1) quart of manufacturer's standard touch-up paint.
   8. One (1) Power Monitoring Unit, where Power Monitoring Units are required by the PLANS.
   9. One (1) - Spare elapsed time meter for each motor control center in which an elapsed time meter is used.

B. Furnish the following tools with the equipment for each MCC in conformance with the specifications:
   1. Provide breaker test set for Solid-State-Trip units for each type used.

1.08 SPECIAL MANUFACTURER SERVICES

A. Prepare an arc-flash study, harmonic study, motor starting study and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services".

B. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to assist in the installation of the equipment. Include checking alignment of parts, wiring connections, operation of all parts (relays, starters, monitoring relays, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the OWNER with a report certifying that the equipment was installed, adjusted, properly tested, and set in accordance with the manufacturer's recommendations and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

C. Manufacturer's technical representative is to set, adjust and test all protective relays, etc. in the presence of a representative of the Owner. The settings will be based on coordination and short circuit studies performed in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services". Provide the Owner with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the

most suitable for the proper protection and coordination of the system at No Additional Cost to the Owner.

D. Any problems encountered with the operation of equipment, parts, components, etc. installed within the MCC line-up shall be repaired/remedied by the manufacturer's technical representative.

PART 2 PRODUCTS

2.01 GENERAL

A. For additional construction notes and special requirements, refer to the PLANS. Also refer and adhere to the requirements of the PLANS.

B. Motor Control Center shall not exceed the dimensions shown on the PLANS. Compartment/component arrangement shall be as shown on the elevation drawings. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below, as shown on the PLANS.

2.02 CONSTRUCTION

A. Structure
   1. Enclosures shall be NEMA Type 1, Gasketed. Enclosure shall be the totally enclosed, dead front, free standing type suitable for back-to-wall mounting.
   2. MCC shall consist of required number of vertical sections bolted together to form a rigid self supporting assembly. Each vertical section shall be nominally 90 inches high. Each vertical section shall be subdivided into compartments (units). Refer to the PLANS for additional dimensional requirements.
   3. The MCC shall contain a top horizontal wireway and a bottom horizontal wireway running the full width of the MCC. The bottom horizontal wireway shall be covered by hinged doors. Each vertical section shall include a top plate and a bottom plate; plates shall be removable.
   4. Each vertical section containing a plug-in unit shall also contain a vertical wireway that interconnects the top and bottom horizontal wireways. The vertical wireway shall be covered by a hinged door.
   5. Each unit within each vertical section shall have a hinged door. Each unit shall have a padlockable disconnect operating handle. Include provisions for up to three padlocks. Handle shall be mechanically interlocked with the door to prevent personnel from opening the door when the unit disconnect is in the ON position. Provide handle-door interlock defeating (bypass) feature. Provide non-defeatable interlock to prevent the installation of a plug-in unit unless the unit disconnect is in the OFF position.
   6. Unused unit spaces in each vertical section shall be covered by hinged blank doors and equipped to accept future units.
   7. All combination starter and feeder units of plug-in construction shall utilize mechanical guides to insure positive alignment of the unit stabs to the section vertical bus. For each unit, shutters shall be provided to cover bus access openings when unit is removed. Unused structure openings shall have plugs or covers to prevent entry of foreign objects into the bus area.

8. Structure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer's standard.
9. Provide each vertical section with an accessible space heater wired to terminal blocks in the respective section. Size the space heater per manufacturer's standard.
10. Structure shall include field removable lifting means.
11. Where an incoming line section is required by the PLANS, the Incoming Line Section shall include lugs for the connection of the field wiring shown on the PLANS.

B. Buses
1. All buses shall be tin plated copper.
2. The main horizontal bus shall extend the entire length of the motor control center. Buses shall be fully rated and the rating shall be based on 65 degrees C maximum temperature rise in a 40 degree C ambient. The main bus shall be rated as shown on the drawings and/or data sheets. Provisions shall be provided to facilitate future extension of the buses.
3. The vertical bus in each section shall be rated for 300 ampere, at minimum.
4. The minimum RMS symmetrical short circuit current rating of the buses shall be as indicated on the one-line diagram drawings.
5. The power buses shall be isolated by barriers from starters, wire troughs, and other areas.
6. A continuous ground bus shall be furnished for the entire length of the MCC. The ground bus shall be rated for 50 percent of the main horizontal power (phase) bus rating, at minimum. Stack multiple ground bus bars as required to provide the required ground bus rating. Provide ground bolted connectors for the size and quantity of wire at each end of the bus as shown on the PLANS.

C. Wiring
1. Unless otherwise noted, the MCC shall be wired Class II, type B construction with terminal blocks for each cubicle.
2. All control wiring shall be tin-plated stranded copper not smaller than #14.
3. All wiring shall be neatly bounded with tie-wraps and supported to wire ways supports.
4. Wiring shall be terminated to split-type terminal blocks.

D. Identification
1. All component and control identification labels shall include the device name and number exactly as it appears on the PLANS. Refer to the PLANS.
2. All control wires shall be tagged and coded with an identification number. Tagging type and wire coding shall be per manufacturer's standard.
3. All terminal blocks shall be identified.
4. Properly label the devices mounted inside each section using manufacturer's standard laminated labels installed in accordance with the manufacturer's standard method.
5. Nameplates:
   a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and

lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   b. Color: White-Black-White
   c. Lettering: Engraved through the face layer to the melamine middle layer. Nameplates located on the face of each section/compartment of each MCC shall be legible at a distance of six feet from the nameplate.
   d. Accessories: Provide holes for mechanical fastening
   e. Attachment Means: Secured with two Stainless Steel screws/bolts per manufacturer's standard; use of adhesives shall not be accepted.
6. Furnish and install nameplates for:
   a. Each equipment/device/etc. installed/mounted on the face of the MCC.
   b. Each exterior section/compartment of each MCC.
   c. Overall entire lineup of MCC, i.e. a master nameplate. In addition to manufacturer's standard information for master nameplates, Master nameplate shall include, at minimum, the tag of the MCC as shown on the PLANS and all information required by the NEC.

2.03 MAIN AND TIE CIRCUIT BREAKERS

A. Rating: Circuit breaker shall be three pole, 600V with a maximum continuous current carrying capacity shown on the PLANS and a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than 42,000 amperes at 480V A.C. Breaker shall be U.L. listed and comply with NEMA Standard No. AB1-1975 and Federal Specification W-C-3758/GEN 21a. Circuit breaker shall be fully rated and not require rating for ambient temperatures 40 degrees Celsius or less.

B. The circuit breakers shall be fixed mounted power operated. The breakers shall be operated by a motor charged stored energy spring mechanism, charged normally by a universal electrical motor, remotely operated from the Distributed Control System, and in an emergency by a manual handle. The primary disconnecting contacts shall be tin-plated copper. The breaker shall include a provision for padlocking open to prevent manual or electric closing. The padlocking shall also secure the breaker in the connected test, or disconnect position by preventing levering. The circuit breaker shall be manufactured by "Square D" model "PowerPact P-Frame" or approved equal.

C. The circuit breakers shall be furnished with the following accessories and options:
   1. Shunt Trip Device
   2. Shunt Close Device
   3. Ready-to-Close Contact
   4. Electrical Closing Pushbutton
   5. Auxiliary Position Switches
   6. Overcurrent Trip Switch
   7. Micrologic Trip Unit Accessories: Circuit breakers shall have an electronic trip (solid state) unit. Trip unit shall be solid state with adjustable long time, short time, instantaneous with ground fault and pick up settings, "Square D" – model Micrologic Trip Unit with Harmonic Metering with specified accessories, with the shunt Trip Unit Attachment, and Internal Ground Fault Protection, or approved equal. Construction shall allow connection of supply conductors at either end.
      a. External Neutral Current Transformer

b. Metering current Transformers
c. Voltage Measurement Inputs
d. Sensor Plugs
e. Adjustable Rating Plugs
f. External Power Supply Module
g. External Battery Backup Module

8. Mechanical operations counter to record the number of circuit breaker operations.

D. The 120VAC source for each MAIN and TIE circuit breaker shall be supplied from a dedicated control power transformer internal to the MCC assembly and connected to the line side of the circuit breaker terminals. The control power transformer(s) shall be provided with fused primary windings and fused secondary windings as specified hereinafter. The Manufacturer shall size the control power transformer, fuses and related interconnect wiring.

E. Provide each circuit breaker with the following 120VAC operators: REMOTE OFF-REMOTE ON selector switch. Selector switch shall be as specified in Section 17200 "Instrumentation and Control Cabinets and Associated Equipment". All breaker control devices shall be wired in accordance to the manufacturer's standard control wiring diagram for power operated circuit breakers. Wire an additional REMOTE OFF-REMOTE ON selector switch contact to control wiring terminal blocks located within the breaker unit compartment indicating that the selector switch is in the "REMOTE ON" position. The selector switch will be monitored by the Distributed Control System as shown on the PLANS.

F. Each circuit breaker shall be furnished with Normally Open (N.O.) and Normally Closed (N.C.) auxiliary breaker status contacts that will change state when the breaker is opened and/or closed. The auxiliary breaker status contacts shall be rated 5-amps at 120VAC. Pre-wire both status contacts to the control wiring terminal blocks located within the breaker unit compartment to be monitored by the Distributed Control System as shown on the PLANS.

G. Provide each circuit breaker with the components required to comply with the Main and Tie Circuit Breaker Control Wiring Schematics shown on the PLANS.

H. Terminations: Breakers shall have removable lugs, U.L. listed for copper and aluminum conductors and U.L. listed for installation of mechanical screw type lugs.
1. Lugs shall be able to accept the quantity of parallel conductors per phase and the size conductor shown on the PLANS. Refer to the PLANS.

2.04 BRANCH FEEDER CIRCUIT BREAKERS

A. Provide thermal magnetic molded case circuit breakers with the following minimum requirements:
1. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the main bus.
2. Circuit breaker shall be three pole, 600 volt with a maximum continuous current carrying capacity shown on the PLANS.

3. Breakers shall operate continuously when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers.
4. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
5. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
6. Provide mechanical padlock attachment for each circuit breaker.
7. Furnish lugs for feeders where required to facilitate field wiring termination, sizes shall be as required by the PLANS.
8. All circuit breakers shall be unit mounted

B. Provide where specifically shown on the PLANS:
1. Current limiting circuit breaker.
2. Electronic trip attachment. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings. Where available from the manufacturer, coat all printed circuit assemblies with a UL 746 recognized conformal coating.
3. Auxiliary contacts rated for 120 volts A.C. Contacts shall satisfy the requirements of the PLANS.

2.05 COMBINATION UNITS

A. Each combination motor controller and feeder unit shall have the following characteristics:
1. Molded case circuit breakers for branch circuit protection. Circuit breakers shall have the following characteristics:
a. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the main bus.
b. Three pole, 600 volt, type and maximum continuous current carrying capacity as shown on the PLANS.
2. Starters shall have the following characteristics:
a. Starters shall be magnetic type, NEMA rated, with 120 volts A.C. operating coils. International type starters (IEC rated), will not be accepted, even if the starters were to show equivalent NEMA ratings.
b. Size and configuration (full voltage non-reversing, full voltage reversing, reduced voltage solid state, etc.) as shown on the PLANS.
c. Provide each starter coil with the manufacturer's standard transient voltage surge suppression module.
d. Provide auxiliary contacts as required by the PLANS. Contacts shall be rated for 120 volts A.C and shall satisfy the requirements of the PLANS. Provide each starter with one (1) normally open auxiliary contact wired to terminal blocks over the number of contacts required by the PLANS.
3. Provide Overload relays where required by the PLANS. Overload relays shall have the following characteristics:
a. Standard class 20, ambient compensated,
b. Manually reset by push-button located on front of the compartment door.
c. Provide with auxiliary contact rated for 120 volts A.C. Contact shall satisfy the requirements of the PLANS.

d. The overload relay heaters will be selected by the Contractor after delivery of the MCC. Include all necessary delivery, packaging, and administrative costs associated with the delivery of overload heaters.

4. Control Power Transformer. The transformer shall have the following characteristics:
   a. Adequately sized to serve all loads shown on the PLANS. Minimum size shall be as follows unless noted otherwise on the PLANS:
      1) NEMA Size 4 and larger starters: 750 VA
      2) All other starters, 200VA
   b. Connect as shown on the PLANS.
5. Provide one single pole fuse block with fuse for each motor space heater.
6. Where required by the PLANS, provide three phase power factor correction capacitor (PFCC) banks. Furnish and install additional requirements as follows:
   a. Manufacturer's standard overload protection for PFCC banks.
   b. Each PFCC bank is dedicated to correct the power factor of a specific pumping unit. The kVAR size/rating shown on the PLANS is a minimum requirement for bidding purposes. The manufacturer shall properly select the kVAR size/rating of the capacitor bank based upon the actual motor load data to ensure an improved operating power factor of greater than or equal to 95 percent (lagging) when the associated distribution pump motor load is in full operating condition. The PFCC banks shall be 480 volt rated PFCC banks.
   c. Connect as shown on the PLANS.
   d. Provide for auxiliary contacts as required by the PLANS. Contacts shall be rated for 120 volts A.C and shall satisfy the requirements of the PLANS.
7. Provide additional requirements as shown on the PLANS.

2.06 SURGE PROTECTIVE DEVICE (SPD)

A. Provide Surge Protective Device system (SPD) were required by the PLANS. The SPD shall have the following characteristics:
   1. SPD shall be tested with the ANSI/IEEE Category C high exposure waveform of 10 kA for 8 x 20 microseconds, at minimum.
   2. Integrated surge protective device recognized in accordance with UL 1449.
   3. Minimum surge current withstand shall be 160 kA per phase (80 kA per mode)
   4. Has a minimum pulse life of 5000 ANSI/IEEE Category C high transients without failure or degradation of clamping voltage by more than 10 percent.
   5. Provide with manufacturer's standard line side disconnect.
   6. Provide visual indication of SPD status
   7. Surge counter.
   8. Provide dry contact failure status output contact. Contact shall be rated for 120 volts A.C. and shall satisfy the requirements of the PLANS.
   9. 5 year warranty, at minimum.

2.07 POWER MONITORING UNIT (PMU)

A. Where required by the PLANS, furnish and install a Power Metering Unit (PMU). The PMUs shall be as manufactured by General Electric - MULTILIN Model EPM 9700 (Transducer Module) with advanced software option complete with three line

LED combination display and keypad Model P40NPLUS, with the Ethernet communication capability, harsh environment UL 746C/94 recognized conformal coating on all printed circuit assemblies and all required interconnect cabling as also shown on the PLANS, No Equal. Units shall be connected as shown on the PLANS.

B. Additional Requirements for the PMU:
   1. Furnish and install an Ethernet connection to the PMU on the Motor Control Center compartment door adjacent to the PMU LED display for accessing PMU settings files.
   2. Where shown on the PLANS, furnish and install a patch panel in accordance with the requirements of Sub-Section 2.09 G, this Section of the Specifications.

2.08 INSTRUMENT TRANSFORMERS

A. General
   1. All instrument transformers specified shall be installed and connected at the factory.

B. Instrument current transformers (C.T.'s):
   1. Provide current transformers where required by the PLANS. Connect as shown on the PLANS.
   2. Current transformers shall be the window type and shall have an ANSI 60 Hz Metering Accuracy Class of 0.3 measured at burden of B0.1, at minimum.
   3. Install a shorting terminal block for each current transformer (C.T.). Prewire all terminals of each C.T. to its respective shorting terminal block. Shorting terminal blocks shall be as manufactured by "G.E.", or approved equal.

C. Instrument Potential Transformers (P.T.'s):
   1. Provide potential transformers where required by the PLANS. Connect as shown on the PLANS.
   2. Potential transformers shall have the following characteristics:
      a. Primary voltage: 480 volts A.C.
      b. Secondary voltage: 120 volts A.C.
      c. Accuracy rating: 0.6 Y at burden of 1.2X
      d. Thermal Burden: 150 VA at 30 degrees C ambient
      e. Frequency: 60 Hz.
   3. Install with primary and secondary disconnect devices, grounding device, and accessories in conformance with IEEE and NEMA standards.
   4. Provide current limiting type primary fuses.

2.09 MISCELLANEOUS ACCESSORIES

A. Pilot Lights:
   1. Type: Transformer Type Light Emitting Diode (LED),
   2. Style: Push-to-test
   3. Lens Color: Furnish and install the colors as shown on the PLANS.
   4. Rating: NEMA 4/13, oil tight and water tight, Heavy Duty
   5. Size: NEMA Style full size 30-millimeter (30mm),

6. Contacts: 10 ampere minimum at 120 volts A.C. Provide number of contacts to satisfy the requirements of the PLANS.
7. Legend Plate: Furnish and install per manufacturer's standard with inscription as shown on the PLANS.
8. Manufacturer: Allen Bradley Bulletin 800T, or approved equal.

B. Control relays shall have the following characteristics:
1. 600 volts, standard NEMA Size, AC Heavy-Duty industrial type with 120 volt AC coils.
2. Minimum contact rating of 10A, continuous, at 120 volts AC.
3. Furnish each relay with one additional Normally Open (N.O.) and one additional Normally Closed (N.C.) contacts over the number required by the PLANS.
4. Provide each relay with Relay Manufacturer's Transient Suppression Module.
5. Relays shall be "Allen Bradley Bulletin 700", Type-700P, or approved equal relays of the MCC manufacturer.

C. Timing Relays shall have the following characteristics:
1. Solid state, multi-time, and multi-function type relay
2. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes:
   a. On Delay
   b. Off Delay
   c. One Shot
   d. Repeat Cycle
   e. Interval
3. Minimum relay contact rating shall be 10 amps, continuous, at 120 VAC.
4. Timing relays shall be Square D Class 9050 model No. JCK70 complete with Type NR61 Socket, or approved equal.

D. Current Transmitter with Integrated Instrument Current Transformer: Where specifically shown on the PLANS, provide a Current Transmitter with Integrated Instrument Current Transformer (ICTT) within the combination motor controller and feeder unit on each ungrounded phase conductor serving the load. Refer to the PLANS. The ICTT shall have the following characteristics:
1. Especially designed for installation in a totally enclosed motor control center.
2. Window type current transformer
3. Input voltage: 24 VDC
4. Output signal: permanently calibrated 4-20 mADC
5. Response time: 200 msec. max., 10-90% Full-Scale
6. Accuracy: ±0.5% Full-Scale
7. Repeatability: Less than 0.1%
8. Output load: 0-600 ohms
9. Insulation class: 600V, BIL 10kV Full Wave
10. Reverse polarity protection
11. Manufacturer: CR-Magnetics, Series CR4320, with specified accessories, or approved equal.

E. Current Sensing Relay with Integrated Instrument Current Transformer: Where specifically shown on the PLANS, provide a Current Sensing Relay with Integrated Instrument Current Transformer (ICTR) within the combination motor controller and

feeder unit on each ungrounded phase conductor serving the load. Refer to the PLANS. The ICTR shall have the following characteristics:

1. Especially designed for installation in a totally enclosed motor control center
2. Window type current transformer
3. Supply power: 120 VAC
4. Calibrated trip point dial
5. Trip status: Trips when sense current is above trip point and returns to non-trip status when sense current is below trip point
6. Trip range: 1.0 to 10 AAC
7. Trip status indicator: LED
8. Frequency: 60 Hz
9. Hysteresis: 5% Maximum
10. Operating temperature: -30° C to +60° C
11. Relay:
    a. Arrangement: One (1) form C
    b. Contact material: Silver-cadmium oxide
    c. Rating: up to 20 amps
12. Manufacturer: CR-Magnetics, Series CR4395-EH-120-110-X-CD-ELR-I, with specified accessories, or approved equal.

F. Elapsed Time Meters shall be the non-resettable type, and shall have cyclometric type reading at least to 9999.9 hours and at least to the nearest one-tenth of an hour. Elapsed time meters shall be as manufactured by Eagle Signal/Danaher Controls series HK410. Mount to the front of the MCC.

G. MCC Space Heater Control Power Transformer for the MCC, where required by the PLANS, shall have the following characteristics:

1. Minimum size as shown on the PLANS. Adjust size as needed to serve the space heater loads.
2. 120 volt AC grounded secondary
3. Connect as shown on the PLANS.
4. The space heater of each vertical section of the MCC shall be individually protected with a fuse mounted in the control power transformer compartment.
5. The space heater circuitry shall be thermostatically controlled by centrally located adjustable thermostat(s). Provide the quantity of thermostats necessary to serve the load of the space heater circuitry.

H. Provide control power transformer, fuses, power supplies, etc., and associated interconnect wiring as required to provide functional control power service to the circuit breaker trip circuitry for proper operation of circuitry, per manufacturer's standard.

I. Provide key interlocks where required by the PLANS.

J. Patch Panel: Where shown on the PLANS, provide a dedicated patch panel for termination of the Ethernet data highway (serial communication) cabling for each Motor Protective Relay/Power Monitoring Unit. Patch panels shall be two-port, DIN-rail mounted, module type, with side lids, Category 6A, as manufactured by "Signamax" KI-DIN-RMM-SL Keystone Industrial DIN-Rail Mounting Module for Keystone Jacks. Furnish patch panel complete with two (2) blue, RJ-45 keystone jacks manufactured by "Signamax" Category 6A MT-Series High Density Keystone

Jacks. Label each port with printed minimum 1/4" high lettering using indelible moisture and heat resistant marking system, black on white. In addition, label the overall patch panel with tag using phenolic tagging. Secure Din-rail to backpanel with screws. Ethernet patch cords shall be furnished and installed between the patch panel and the respective power monitoring unit/protective relay per the requirements of Section 17600 "Distributed Control System". Length of patch cords shall be such to have one full coil of slack cable at a minimum to reduce physical strain on cable termination.

2.10 METAL ENCLOSED OVERHEAD BUS DUCT

A. Furnish and install metal enclosed bus duct were required by the PLANS. The overhead bus duct shall have the following characteristics:
   1. All buses shall be tin plated copper.
   2. All buses shall be insulated with manufacturer's standard insulation.
   3. Buses shall be fully rated and the rating shall be based on 55 degrees C maximum temperature rise in a 40 degree C ambient. The bus continuous current rating shall be as shown on the PLANS.
   4. The minimum RMS symmetrical short circuit current rating of the buses shall be as indicated on the one-line diagram drawings.
   5. Dedicated continuous ground bus shall be furnished for the entire length of the bus duct. The ground bus shall be rated for 50 percent of the main power (phase) bus rating, at minimum.
   6. The bus duct shall have the "sandwich" type configuration with no air gap between bus bars.

B. Bus duct enclosure shall have the following characteristics:
   1. Totally enclosed, non-ventilated, suitable for indoor use
   2. Fabricated from aluminum or steel per manufacturer's standard.
   3. Finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer's standard.

C. Provide with all necessary joints, fittings, covers, adapters, hardware, etc., as required for a complete and functional bus duct installation. This shall include, but not be limited to:
   1. Elbows, flanges, TEE fittings,
   2. Flexible connectors,
   3. All necessary covers for openings,
   4. Thermal expansion fitting when bus duct crosses a building expansion joint. Refer to the PLANS for locations of building expansion joints.

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TEST

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the

test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Install per manufacturer's instructions and recommendations. Install all required safety labels.

B. Perform manufacturer's field services as previously specified.

C. Size, furnish and install the overload relay heaters based on actual motor nameplate current. Set overload relay settings at maximum values permitted by the NEC 430-32.

D. Size, furnish and install the motor space heater fuses based on actual motor space heater load current.

3.03 FIELD TEST AND CHECKS

A. Verify proper rotation of all motor loads

B. Verify motor space heater circuits are operational..

C. The following minimum test and checks shall be made before energizing the MCCs. These tests shall be performed by a Factory Trained Field Technician (non sales type):
   1. Thoroughly inspect the MCC.
   2. Test for proper phasing of power connections. Additionally, check phasing across the MCCs and connecting overhead bus duct/tie feeders (as applicable) using phasing sticks.
   3. Set, adjust, and test all protective relays based on the results of the coordination study, refer to sub-section 1.08, this Section of the Specifications.
   4. Megger terminals and buses for grounds, test per manufacturer's recommendations.
   5. Verify ratios of all CT's, and proper operation of all metering.
   6. Verify MCC enclosure space heater circuits are operational.
   7. Test key interlock system functionality
   8. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Submit documentation of all tests outlined above.

E. Submit manufacturer's certification report per sub-section 1.08, this Section of the Specifications.

3.04 EQUIPMENT PROTECTION AND RESTORATION

A. Clean and vacuum all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

C. Energize the space heaters within the MCC and energize during storage and installation for humidity control.

3.05 TRAINING

A. Provide training sessions for owner's representatives for Two (2) FULL normal workdays at the job-site location and/or at a location determined by the OWNER. If training is conducted in less than the time required by these specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the MCC manufacturer's non-sales-type technical representative, who performed the field installation and start-up/setting/adjustment services.

C. At minimum, the training session shall include:
   1. Operation and maintenance procedure for the equipment and all components installed within the MCCs.
   2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.
   3. Potential of arc-flash hazards associated with working on energized equipment.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

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SECTION 16121

MODIFICATIONS TO EXISTING 480 VOLT MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Scope of Work
   1. The Contractor shall furnish and install the modifications required to the Owner's existing motor control centers as specified herein and as shown on the PLANS.
   2. The existing motor control centers are vital to the Owner's waste-water treatment plant process system. Therefore, required interruptions to the plant process shall be minimized and carefully coordinated with the Owner. Regarding interruptions, refer to and comply with the General Notes shown on the Electrical PLANS.
   3. The arrangement and dimensions of the existing motor control centers are based on the data available and information provided by the Owner and based on site investigations. The Contractor shall also field verify all available data/information prior to commencement of the improvements required under this project. Should any deviation be found between the PLANS and the Contractor's site findings, it shall be brought to the attention of the Owner prior to Bid. Otherwise, it shall be assumed that conditions are as is and no additional, less, and/or departure of work is expected from what is shown on the PLANS and Specified herein.

1.02 RELATED WORK NOT INCLUDED

A. The PLANS designate the type, number, size and rating of devices included in the Motor Control Centers (MCCs)

B. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:
   1. Dimensioned/scaled top and bottom views, front elevations, and internal component/device layouts
   2. One-line diagrams and wiring diagrams,
   3. Catalog cut sheets. Include protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable.
   4. Key interlock scheme drawing and sequence of operations, where applicable.

1.04 OPERATION AND MAINTENANCE MANUALS

A. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:
   1. Installation and operation manuals.
   2. Renewal parts bulletin.
   3. As built drawings, including approved shop drawings.
   4. Test data.
   5. Sealed and signed arc flash hazard analysis, harmonic study, motor starting, short circuit, and coordination study report. Report to include all final setpoints used.

B. Additional information as required by subsection 1.08, this section of the Specifications.

1.05 QUALITY ASSURANCE

A. All parts and distribution and control equipment required to modify the existing motor control centers shall be the product of the original manufacturer of the motor control centers and/or as recommended/approved by the original manufacturer of the motor control centers, NO EQUAL, for use in the existing Motor Control Centers, and as also called for on the PLANS and in compliance with this Section of the Specifications. Substitute manufacturers will not be accepted.

B. Modifications to the motor control centers shall be performed and tested in accordance with the latest applicable requirements of NEMA, ANSI, UL, and NEC standards. Modifications to the motor control centers shall be performed by qualified, experienced, manufacturer trained technical (non-sales type) representative, or Engineering Services Group trained technical (non-sales type) representative, or Original Equipment Manufacturer's trained technical (non-sales type) representative, by Siemens, Allen Bradley, Square-D Company, Asian Brown Boveri, Eaton Corporation, or approved equal.

C. In addition to these Specifications, refer to the PLANS for specific requirements on the Motor Control Centers.

1.06 STORAGE AND HANDLING

A. Protection
   1. The Contractor, and hence the MCC supplier, shall be responsible for safety of the MCC during storage, transporting and handling.
   2. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.
   3. Products shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
   4. At all times, store products inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   5. Interior and exterior of MCC shall be kept clean at all times.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:
   1. Environmentally protected and stored in climate controlled (temperature, humidity, and non-corrosive class) environment at the job site. Size, furnish and install temporary gaseous air scrubbers, air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
      a. Ambient Dry Bulb Temperature:
         1) Minimum: 68 degrees Fahrenheit.
         2) Maximum: 85 degrees Fahrenheit.
      b. Ambient Relative Humidity: Maximum: 50%.
      c. Ambient Corrosion Level: International Society of Automation Class: G1
   2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
   3. Upon arrival of equipment onto job site, a maximum of one day shall be allowed for equipment to be left without to allow proper transition of power of equipment, especially any 120 VAC powered equipment, to ensure all air conditioning, heating, and gaseous air scrubbing equipment are fully operational with a maximum of a 10 minute down time during this transition of power.
   4. Furnish and install replacement air scrubber media, air filters, etc., as required for proper operation of the environmental control equipment.

1.07 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each MCC in conformance with the specifications:
   1. One (1) – Set of fuses (minimum 3) for each type and size used.
   2. One (1) – Set of starter contacts for every three (3) like starters used (a minimum of 1 for each size used). If contacts are not replaceable a spare starter for each size used shall be supplied.
   3. Two (2) - Contactor coils for every NEMA size and type starter installed, a minimum of one coil per size.
   4. Two (2) - Spare control relays for each type used. Control relay shall be furnished complete with relay coils, Four (4) Normally Open (N.O.) contacts, Four (4) Normally Closed (N.C.) contacts, and shall be furnished with Relay Manufacturer's Transient Voltage Suppression Module.
   5. One (1) - Spare timing relay.
   6. Two (2) – Sets of overload heaters for each size and type used.
   7. One (1) quart of manufacturer's standard touch-up paint.
   8. One (1) - Spare elapsed time meter for each motor control center in which an elapsed time meter is used.

1.08 SPECIAL MANUFACTURER SERVICES

A. Prepare an arc-flash study, harmonic study, motor starting study and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services".

B. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to assist in the installation of the equipment. Include checking alignment of parts, wiring connections, operation of all parts (relays, starters, monitoring relays, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the OWNER with a report certifying that the equipment was installed, adjusted, properly tested, and set in accordance with the manufacturer's recommendations and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

C. Manufacturer's technical representative is to set, adjust and test all protective relays, etc. in the presence of a representative of the Owner. The settings will be based on coordination and short circuit studies performed in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services". Provide the Owner with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the Owner.

D. Any problems encountered with the operation of equipment, parts, components, etc. installed within the MCC line-up shall be repaired/remedied by the manufacturer's technical representative.

PART 2 PRODUCTS

2.01 GENERAL

A. For additional construction notes and special requirements, refer to the PLANS. Also refer and adhere to the requirements of the PLANS.

B. Motor Control Center shall not exceed the dimensions shown on the PLANS. Compartment/component arrangement shall be as shown on the elevation drawings. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below, as shown on the PLANS.

C. The requirements described herein and as shown on the PLANS apply to any modification work to the MCCs including the relocating and/or modification of existing breaker/combination starter compartments, addition of combination starter compartments, addition of breaker only compartments, etc.

2.02 CONSTRUCTION

A. Structure
   1. Enclosures shall be NEMA Type 1, Gasketed. Enclosure shall be the totally enclosed, dead front, free standing type suitable for back-to-wall mounting.
   2. MCC shall consist of required number of vertical sections bolted together to form a rigid self supporting assembly. Each vertical section shall be nominally

90 inches high. Each vertical section shall be subdivided into compartments (units). Refer to the PLANS for additional dimensional requirements.

3. The MCC shall contain a top horizontal wireway and a bottom horizontal wireway running the full width of the MCC. The bottom horizontal wireway shall be covered by hinged doors. Each vertical section shall include a top plate and a bottom plate; plates shall be removable.
4. Each vertical section containing a plug-in unit shall also contain a vertical wireway that interconnects the top and bottom horizontal wireways. The vertical wireway shall be covered by a hinged door.
5. Each unit within each vertical section shall have a hinged door. Each unit shall have a padlockable disconnect operating handle. Include provisions for up to three padlocks. Handle shall be mechanically interlocked with the door to prevent personnel from opening the door when the unit disconnect is in the ON position. Provide handle-door interlock defeating (bypass) feature. Provide non-defeatable interlock to prevent the installation of a plug-in unit unless the unit disconnect is in the OFF position.
6. Unused unit spaces in each vertical section shall be covered by hinged blank doors and equipped to accept future units.
7. All combination starter and feeder units of plug-in construction shall utilize mechanical guides to insure positive alignment of the unit stabs to the section vertical bus. For each unit, shutters shall be provided to cover bus access openings when unit is removed. Unused structure openings shall have plugs or covers to prevent entry of foreign objects into the bus area.
8. Structure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer's standard.
9. Provide each vertical section with an accessible space heater wired to terminal blocks in the respective section. Size the space heater per manufacturer's standard.
10. Structure shall include field removable lifting means.
11. Where an incoming line section is required by the PLANS, the Incoming Line Section shall include lugs for the connection of the field wiring shown on the PLANS.

B. Wiring
   1. Unless otherwise noted, the MCC shall be wired Class II, type B construction with terminal blocks for each cubicle.
   2. All control wiring shall be tin-plated stranded copper not smaller than #14.
   3. All wiring shall be neatly bounded with tie-wraps and supported to wire ways supports.
   4. Wiring shall be terminated to split-type terminal blocks.

C. Identification
   1. All component and control identification labels shall include the device name and number exactly as it appears on the PLANS. Refer to the PLANS.
   2. All control wires shall be tagged and coded with an identification number. Tagging type and wire coding shall be per manufacturer's standard.
   3. All terminal blocks shall be identified.
   4. Properly label the devices mounted inside each section using manufacturer's standard laminated labels installed in accordance with the manufacturer's standard method.

5. Nameplates:
    a. Type: 3-ply, 1/8” thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
    b. Color: White-Black-White
    c. Lettering: Engraved through the face layer to the melamine middle layer. Nameplates located on the face of each section/compartment of each MCC shall be legible at a distance of six feet from the nameplate.
    d. Accessories: Provide holes for mechanical fastening
    e. Attachment Means: Secured with two Stainless Steel screws/bolts per manufacturer’s standard; use of adhesives shall not be accepted.
6. Furnish and install nameplates for:
    a. Each equipment/device/etc. installed/mounted on the face of the MCC.
    b. Each exterior section/compartment of each MCC.
    c. Overall entire lineup of MCC, i.e. a master nameplate. In addition to manufacturer’s standard information for master nameplates, Master nameplate shall include, at minimum, the tag of the MCC as shown on the PLANS and all information required by the NEC.

2.03 MAIN AND TIE CIRCUIT BREAKERS

A. Rating: Circuit breaker shall be three pole, 600V with a maximum continuous current carrying capacity shown on the PLANS and a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than 42,000 amperes at 480V A.C. Breaker shall be U.L. listed and comply with NEMA Standard No. AB1-1975 and Federal Specification W-C-3758/GEN 21a. Circuit breaker shall be fully rated and not require rating for ambient temperatures 40 degrees Celsius or less.

B. Circuit breaker shall be furnished with solid state type electronic trip attachment. The attachment shall have the following minimum features:
    1. Alpha-numeric display
    2. Circuit breaker test receptacle
    3. Field adjustable settings:
        a. Long time pickup
        b. Long time delay
        c. Short time pickup
        d. Short time delay
        e. Instantaneous pickup
        f. Ground fault pickup
        g. Ground fault delay
    4. Where available from the manufacturer, coat all printed circuit assemblies with a UL 746 recognized conformal coating.

C. Circuit breaker shall be fixed mounted power operated. The breaker shall be operated by an electric motor operator, remotely operated from the Distributed Control System, and in an emergency by a manual handle. The breaker shall include a provision for padlocking open to prevent manual or electric closing. The padlocking shall also secure the breaker in the connected test, or disconnect

position by preventing levering. The circuit breaker shall be manufactured by "Siemens" model "ND Series" or approved equal.

D. The circuit breakers shall be furnished with the following accessories and options:
   1. Alarm switch to energize an Owner furnished warning device. Alarm switch contact shall close when the circuit breaker trips open. Wire alarm contact to terminal blocks for Owner use as shown on the PLANS.
   2. Auxiliary switch equipped with one normally open contact and one normally closed contact to provide remote ON or OFF indication. The auxiliary switch shall activate when the circuit breaker trips open. Wire both contacts to terminal blocks for Owner use as shown on the PLANS.
   3. Electric motor operator designed to open, close and reset the circuit breaker by remote control. The electric motor operator shall have the following minimum features:
      a. Compatible with Siemens Type ND breaker frame
      b. Operating Voltage: 120 VAC
      c. Operating Current:
         1) 13.2 Amperes Running
         2) 30.2 Amperes In-Rush
      d. Operating Time:
         1) On: 240 msec.
         2) Off: 210 msec.
      e. Manufacturer: Electric motor operator shall be Telemand® Motor Operator catalog number EMOPL120MN as manufactured by Siemens, or approved equal.

E. The 120VAC source for each MAIN and TIE circuit breaker shall be supplied from a dedicated control power transformer internal to the MCC assembly and connected to the line side of the circuit breaker terminals. The control power transformer(s) shall be provided with fused primary windings and fused secondary windings as specified hereinafter. The Manufacturer shall size the control power transformer, fuses and related interconnect wiring.

F. Provide each circuit breaker with the components required to comply with the Main and Tie Circuit Breaker Control Wiring Schematics shown on the PLANS.

G. Terminations: Breakers shall have removable lugs, U.L. listed for copper and aluminum conductors and U.L. listed for installation of mechanical screw type lugs.
   1. Lugs shall be able to accept the quantity of parallel conductors per phase and the size conductor shown on the PLANS. Refer to the PLANS.

2.04 BRANCH FEEDER CIRCUIT BREAKERS

A. Provide thermal magnetic molded case circuit breakers with the following minimum requirements:
   1. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the main bus.
   2. Circuit breaker shall be three pole, 600 volt with a maximum continuous current carrying capacity shown on the PLANS.

3. Breakers shall operate continuously when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers.
4. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
5. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
6. Provide mechanical padlock attachment for each circuit breaker.
7. Furnish lugs for feeders where required to facilitate field wiring termination, sizes shall be as required by the PLANS.
8. All circuit breakers shall be unit mounted

B. Provide where specifically shown on the PLANS:
1. Current limiting circuit breaker.
2. Electronic trip attachment. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings. Where available from the manufacturer, coat all printed circuit assemblies with a UL 746 recognized conformal coating.
3. Auxiliary contacts rated for 120 volts A.C. Contacts shall satisfy the requirements of the PLANS.

2.05 COMBINATION UNITS

A. Each combination motor controller and feeder unit shall have the following characteristics:
1. Molded case circuit breakers for branch circuit protection. Circuit breakers shall have the following characteristics:
a. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the main bus.
b. Three pole, 600 volt, type and maximum continuous current carrying capacity as shown on the PLANS.
2. Starters shall have the following characteristics:
a. Starters shall be magnetic type, NEMA rated, with 120 volts A.C. operating coils. International type starters (IEC rated), will not be accepted, even if the starters were to show equivalent NEMA ratings.
b. Size and configuration (full voltage non-reversing, full voltage reversing, reduced voltage solid state, etc.) as shown on the PLANS.
c. Provide each starter coil with the manufacturer's standard transient voltage surge suppression module.
d. Provide auxiliary contacts as required by the PLANS. Contacts shall be rated for 120 volts A.C and shall satisfy the requirements of the PLANS. Provide each starter with one (1) normally open auxiliary contact wired to terminal blocks over the number of contacts required by the PLANS.
3. Provide Overload relays where required by the PLANS. Overload relays shall have the following characteristics:
a. Standard class 20, ambient compensated,
b. Manually reset by push-button located on front of the compartment door.
c. Provide with auxiliary contact rated for 120 volts A.C. Contact shall satisfy the requirements of the PLANS.

d. The overload relay heaters will be selected by the Contractor after delivery of the MCC. Include all necessary delivery, packaging, and administrative costs associated with the delivery of overload heaters.

4. Control Power Transformer. The transformer shall have the following characteristics:
   a. Adequately sized to serve all loads shown on the PLANS. Minimum size shall be as follows unless noted otherwise on the PLANS:
      1) NEMA Size 4 and larger starters: 750 VA
      2) All other starters, 200VA
   b. Connect as shown on the PLANS.
5. Provide one single pole fuse block with fuse for each motor space heater.
6. Where required by the PLANS, provide three phase power factor correction capacitor (PFCC) banks. Furnish and install additional requirements as follows:
   a. Manufacturer's standard overload protection for PFCC banks.
   b. Each PFCC bank is dedicated to correct the power factor of a specific pumping unit. The kVAR size/rating shown on the PLANS is a minimum requirement for bidding purposes. The manufacturer shall properly select the kVAR size/rating of the capacitor bank based upon the actual motor load data to ensure an improved operating power factor of greater than or equal to 95 percent (lagging) when the associated distribution pump motor load is in full operating condition. The PFCC banks shall be 480 volt rated PFCC banks.
   c. Connect as shown on the PLANS.
   d. Provide for auxiliary contacts as required by the PLANS. Contacts shall be rated for 120 volts A.C and shall satisfy the requirements of the PLANS.
7. Provide additional requirements as shown on the PLANS.

2.06 MISCELLANEOUS ACCESSORIES

A. Pilot Lights:
   1. Type: Transformer Type Light Emitting Diode (LED),
   2. Style: Push-to-test
   3. Lens Color: Furnish and install the colors as shown on the PLANS.
   4. Rating: NEMA 4/13, oil tight and water tight, Heavy Duty
   5. Size: NEMA Style full size 30-millimeter (30mm),
   6. Contacts: 10 ampere minimum at 120 volts A.C. Provide number of contacts to satisfy the requirements of the PLANS.
   7. Legend Plate: Furnish and install per manufacturer's standard with inscription as shown on the PLANS.
   8. Manufacturer: Allen Bradley Bulletin 800T, or approved equal.

B. Control relays shall have the following characteristics:
   1. 600 volts, standard NEMA Size, AC Heavy-Duty industrial type with 120 volt AC coils.
   2. Minimum contact rating of 10A, continuous, at 120 volts AC.
   3. Furnish each relay with one additional Normally Open (N.O.) and one additional Normally Closed (N.C.) contacts over the number required by the PLANS.
   4. Provide each relay with Relay Manufacturer's Transient Suppression Module.

5. Relays shall be “Allen Bradley Bulletin 700”, Type-700P, or approved equal relays of the MCC manufacturer.

C. Timing Relays shall have the following characteristics:
   1. Solid state, multi-time, and multi-function type relay
   2. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes:
      a. On Delay
      b. Off Delay
      c. One Shot
      d. Repeat Cycle
      e. Interval
   3. Minimum relay contact rating shall be 10 amps, continuous, at 120 VAC.
   4. Timing relays shall be Square D Class 9050 model No. JCK70 complete with Type NR61 Socket, or approved equal.

D. Elapsed Time Meters shall be the non-resettable type, and shall have cyclometric type reading at least to 9999.9 hours and at least to the nearest one-tenth of an hour. Elapsed time meters shall be as manufactured by Eagle Signal/Danaher Controls series HK410. Mount to the front of the MCC.

E. MCC Space Heater Control Power Transformer for the MCC, where required by the PLANS, shall have the following characteristics:
   1. Minimum size as shown on the PLANS. Adjust size as needed to serve the space heater loads.
   2. 120 volt AC grounded secondary
   3. Connect as shown on the PLANS.
   4. The space heater of each vertical section of the MCC shall be individually protected with a fuse mounted in the control power transformer compartment.
   5. The space heater circuitry shall be thermostatically controlled by centrally located adjustable thermostat(s). Provide the quantity of thermostats necessary to serve the load of the space heater circuitry.

F. Provide control power transformer, fuses, power supplies, etc., and associated interconnect wiring as required to provide functional control power service to the circuit breaker trip circuitry for proper operation of circuitry, per manufacturer’s standard.

G. Provide key interlocks where required by the PLANS.

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TEST

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Perform Motor Control Center modifications in accordance with manufacturer's written guidelines, the NEC, and local codes.

B. Refinish all painted steel work that was damaged during Motor Control Center modification activities. Finish shall match the existing Motor Control Center.

C. Install all required safety labels.

D. Perform manufacturer's field services as previously specified.

E. Size, furnish and install the overload relay heaters based on actual motor nameplate current. Set overload relay settings at maximum values permitted by the NEC 430-32.

F. Size, furnish and install the motor space heater fuses based on actual motor space heater load current.

3.03 FIELD TEST AND CHECKS

A. Verify proper rotation of all motor loads

B. Verify motor space heater circuits are operational..

C. The following minimum test and checks shall be made before energizing the MCCs. These tests shall be performed by a Factory Trained Field Technician (non sales type):
   1. Thoroughly inspect the MCC.
   2. Test for proper phasing of power connections.
   3. Set, adjust, and test all protective relays based on the results of the coordination study, refer to sub-section 1.08, this Section of the Specifications.
   4. Megger terminals and buses for grounds, test per manufacturer's recommendations.
   5. Verify MCC enclosure space heater circuits are operational.
   6. Test key interlock system functionality

D. Submit documentation of all tests outlined above.

E. Submit manufacturer's certification report per sub-section 1.08, this Section of the Specifications.

3.04 EQUIPMENT PROTECTION AND RESTORATION

A. Clean and vacuum all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

C. Energize the space heaters within the MCC and energize during storage and installation for humidity control.

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

A. Furnish and install all cabinets, junction boxes, pull boxes and outlet boxes as shown on the drawings, required by the specifications or NEC, or as otherwise necessary for a satisfactory operating system.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced and shall apply as if written here in their entirety. The publications are referred to in the text by basic designation only.

1. NFPA 70 National Electrical Code (NEC)

2. ANSI 514 Electrical Outlet Boxes and fittings

3. ANSI OS 1 Cast Aluminum Outlet Boxes, Device Boxes, Covers and Box Supports, and Steel Covers.

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300.

B. Submit a letter certifying full and complete compliance with the Specifications, Drawings and other project requirements. The letter shall list any exceptions or deviations from specified requirements, if any and reasons for same. Exceptions or deviation shall also be clearly marked in a separate color in submittals.

C. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section 01730.

1.07 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. JUNCTION AND PULL BOXES

1. Junction box shall be NEMA 4X constructed of 316 stainless steel. Junction boxes 12" X 12" X 6" and smaller, may be manufactured of aluminum. All splices to be connected to terminal blocks inside junction box. Covers shall be hinged and latches shall be a quarter turn screw. Box to be a Hoffman Concept Series, Rittal Corporation, Saginaw or equal.

2. Junction boxes mounted flush in the wall are to be galvanized metal boxes rated for exposure to material it comes in contact with.

3. Provide boxes conforming to NEC Article 314.

4. Listing: UL 514.

B. RECEPTACLES AND LIGHT SWITCH BOXES

1. All outlet and switch boxes installed outdoor and indoor to be of one piece. All boxes to be provided with covers of the same manufacture as the boxes. The type of cover selected must meet the conditions imposed in every case or as indicated by Engineer. Outdoor receptacle covers shall be While-In-Use Covers per NEC.

2. Boxes shall be sand-cast aluminum, 100% copper-free. Boxes to be manufactured by Crouse-Hinds, Appleton, or approved equal, type FS-SA and FD-SA, with above options and accessories.

3. Masonry boxes

   a. Provide stamp metal masonry boxes,

   b. Use boxes with 1-gang capacity in excess of the number of devices to be installed,

   c. Extension ring covers shall not be acceptable.

4. Listing: UL 514.

C. TERMINATION CABINETS & BOXES

1. Termination cabinets shall be NEMA 4X 316 stainless steel gasketed. Cabinets shall be of sufficient size to adequately contain all terminals, wire-duct, and cables as determined by the CONTRACTOR. Cabinets shall have removable doors (lift-off) not more than 30-inches wide, and shall be equipped with a three point locking latch handle.

2. Wire terminal blocks shall be Square D Type M Barrier Block system, or equal.

   a. M4/6G or B 22014 AWG 6 MM (.234 inch) wide, Grey, Blue, Single Level, 600 volt, 25 amp.

b. M6-8G or B 22-8AWG 8MM (.315 inch) wide, Grey Blue, Single Level, 600 volt, 55 amp.

3. The wire terminal block system shall be for DIN rail mounting, and shall include fuse/switch blocks, circuit breaker block, and isolation switches.

D. Acceptable Manufacturers:

1. Hoffman, or approved equal.

2.03 -2.04 (NOT USED)

PART III - EXECUTION

3.01 (NOT USED)

3.02 PREPARATION

A. Coordinate location of all boxes with all other work.

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Junction and Pull boxes:

1. Set junction and pull boxes square and true with building surfaces. Secure boxes firmly to 316 Stainless Steel strut support channels.

2. Install boxes as required to facilitate cable installation in raceway systems.

3. Generally provide boxes in conduit runs of more than 100 feet.

4. Locate boxes strategically and make them of such shape and size to permit easy pulling of wire or cables. Size boxes in accordance to NEC Article 314.28 requirements.

B. Outlet Boxes

1. Flush Boxes:

a. Unless otherwise indicated, mount all outlet boxes flush within 1/4-inch of the finished wall or ceiling line

b. Securely fasten outlet boxes in position using clips or other suitable means.

2. Mounting Height:

a. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate.

1) Switches shall be mounted at 50-inches

2) Receptacles shall be mounted at 36-inches

3) Remove and relocate any outlet box placed in an unsuitable location.

b. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation.

c. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall.

d. Verify the final location of each outlet with Engineer before rough-in.

3. Box Openings:

a. Provide only the conduit openings necessary to accommodate the conduits at the individual location.

3.04 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

A. No separate payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 16140

SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies 480-Volt Switchboards (SWBDs) and Metal Enclosed Overhead Bus Duct. The Contractor shall furnish and install SWBDs and Metal Enclosed Overhead Bus Duct as herein specified and shown on the PLANS.

B. Where Bus Duct is required by the PLANS, the Contractor shall furnish and install the Bus Duct system including all necessary fittings, hangers, and accessories as specified herein and as shown on the PLANS.

C. Each SWBD shall be close coupled with a low voltage motor control center as specified in Section 16120 “480 Volt Motor Control Centers” and as shown on the PLANS. Refer to Section 16120 “480 Volt Motor Control Centers” of the Specifications.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors. Suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.

C. The PLANS designate the type, number, size and rating of devices included in the SWBDs.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 (NOT USED)

1.04 QUALITY ASSURANCE

A. All SWBDs on the project shall be manufactured by a single SWBD manufacturer. The manufacturer of the SWBDs shall also manufacture the majority of components and subsystems therein (i.e., circuit breakers, etc.). The manufacturer of the SWBD shall also manufacture the bus duct as well as the 480 Volt Motor Control Center specified in Section 16120.

B. The SWBDs and bus duct shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, UL, and NEC standards.

C. SWBDs and bus duct shall be as manufactured by Square D Company, Asea Brown Boveri, Eaton Cutler Hammer Corporation, or approved equal.

1.05 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:
   1. Dimensioned/scaled top and bottom views, front elevations, and overhead bus duct connection
   2. One-line diagrams and wiring diagrams
   3. Catalog cut sheets. Include protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable.
   4. Key interlock scheme drawing and sequence of operations, where applicable.

B. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:
   1. Installation and operation manual.
   2. Renewal parts bulletin.
   3. As built drawings, including approved shop drawings.
   4. Test data.

1.06 DELIVERY STORAGE AND HANDLING

A. Protection:
   1. The Contractor, and hence the SWBD supplier, shall be responsible for safety of the SWBD and associated bus duct during storage, transporting and handling.
   2. The SWBD shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
   3. At all times the SWBD shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   4. Interior and exterior of SWBD shall be kept clean at all times.
   5. Energize the space heaters within the SWBD and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:
   1. Environmentally protected and stored in climate controlled (temperature, humidity, and non-corrosive class) environment at the job site. Size, furnish and install temporary gaseous air scrubbers, air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
      a. Ambient Dry Bulb Temperature:
         1) Minimum: 68 degrees Fahrenheit.
         2) Maximum: 85 degrees Fahrenheit.
      b. Ambient Relative Humidity: Maximum: 50%.
      c. Ambient Corrosion Level: International Society of Automation Class: G1
   2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.

3. Upon arrival of equipment onto job site, a maximum of one day shall be allowed for equipment to be left without to allow proper transition of power of equipment, especially any 120 VAC powered equipment, to ensure all air conditioning, heating, and gaseous air scrubbing equipment are fully operational with a maximum of a 10 minute down time during this transition of power.
4. Furnish and install replacement air scrubber media, air filters, etc., as required for proper operation of the environmental control equipment.

1.07 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each SWBD in conformance with the specifications:
   1. One (1) – Set of fuses (minimum 3) for each type and size used.
   2. One (1) Power Monitoring Unit (PMU).
   3. Provide breaker test set for Solid-State-Trip units for each type used.
   4. One (1) quart of touch-up paint.

1.08 SPECIAL MANUFACTURER'S SERVICES

A. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to assist in the installation of the equipment. Include checking alignment of parts, wiring connections, operation of all parts (relays, starters, monitoring relays, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the Owner with a report certifying that the equipment was installed properly tested and set in accordance with the specifications and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

B. Manufacturer's technical representative is to set, adjust and test all circuit breakers, relays, motor circuit protectors, etc. in the presence of a representative of the OWNER. The settings will be based on coordination and short circuit studies performed per subsection 1.08.D, this Section of the Specifications. Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and 01730 of the Contract Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.

C. Any problems encountered with the operation of equipment, parts, components, etc. installed within the SWBDs line-up, and associated bus duct, shall be repaired/remedied by the manufacturer's technical representative.

D. Prepare load analysis studies, motor starting studies, arc-flash hazard analysis studies, harmonic studies, and coordination studies, complete with short circuit calculations and coordination curves reflecting calculated fault values and recommended and/or proposed fuse type/ratings, motor protective relay settings, equipment/cable thermal (damage) limits, equipment/device settings (as applicable) as follows:

1. From the Bluebonnet Electric 12470V level (with close coordination with Bluebonnet Electric upstream devices) through the 208/120V subsystem level equipment and devices of the proposed Wild Horse Wastewater Treatment Plant Substation No. 1 (SUB1) Building and the existing Wild Horse Wastewater Treatment Plant Operations Building. Coordination with Bluebonnet Electric is required. Additional details concerning the implementation of the studies such as main-tie-tie-main circuit breaker states to be assumed, etc., will be provided after Bid Award during the Pre-Submittal conference. Thevenin equivalent system characteristics for the 480V system at the SUB1 Building and at the Operations Building will be provided by the Owner after Bid Award to facilitate the Contractor's system study effort.

E. Prepare motor starting studies for the Wild Horse Ranch Wastewater Treatment Plant complete with load calculations and voltage dip curves reflecting calculated load, voltage, motor and load speed-torque characteristics and values, tabulated voltage dip duration and magnitude at the utility service 480V level, and recommended and/or proposed protective relay settings, reduced voltage auto-transformer starter tap settings, start to run transition time settings, variable frequency drive ramp settings, equipment/device settings (as applicable), etc. for all proposed motor starters/distribution equipment as well as all modified starters/distribution equipment on the project. In the studies, include the previously mentioned Thevenin equivalent system characteristics provided by the Owner. All studies shall be performed assuming each pump starts against a closed discharge valve. Assume that the pump discharge valve will open once the pump motor reaches full speed. Verify and coordinate the validity of these assumptions and the sequence of valve operation with the Owner after Bid Award and follow the recommendations of the Owner regarding the process system operation. Repeat all motor starting studies for each type of variable speed drive ramp profile (current limit, voltage ramp, etc.) available for the proposed variable speed drive, and also among each ramp profile with a minimum of five different limiting settings as applicable for each ramp profile, to determine the optimal setpoints to successfully start the load while minimizing service voltage dip. Additionally, perform all motor starting studies assuming one main utility service is energized, the tie circuit breakers are closed, and the second main utility service is de-energized. Perform the motor starting studies for the sequential progressive starting of the proposed pumping units. Repeat studies for each process area electrical service.

F. Perform the arc flash hazard analysis in conjunction with the short circuit and coordination analysis previously described herein and also in compliance with IEEE 1584 and NFPA 70E standards. The flash protection boundary and incident energy shall be calculated at all points in the distribution system (transformers, motor control centers, switchboards, panelboards, variable frequency drives, etc.) where work could be performed on energized parts. The following additional requirements apply for the arc flash hazard analysis:

1. Perform arc flash hazard studies assuming one main utility service is energized, the tie circuit breakers are closed, and the second main utility service is de-energized.
2. Repeat studies for each main utility electrical service.
3. Additionally, perform arc flash hazard studies assuming both main utility services are energized and the tie circuit breakers are open
4. Repeat arc flash hazard studies using reduced short circuit current magnitudes where applicable per IEEE 1584 recommendations.
5. Calculations to address worst case (maximum) hazard analysis for each scenario. Describe scenarios employed and tabulate associated arc flash hazard results in submittals.

G. The arc flash hazard analysis effort shall also include:
   1. Reporting incident energy values based upon recommended protective device settings for all equipment,
   2. Reporting recommendations to reduce AFIE levels and enhance worker safety
   3. Furnish and install label(s) for all equipment included in the study indicating the following, at minimum:
      a. System voltage
      b. Shock and Flash protection boundaries
      c. Personal protective equipment requirements for each electrical task based upon hazard category (including flame resistant clothing requirements).
      d. Arc flash incident energy value (cal/cm2)
      e. Limited and restricted approach boundaries
      f. Study report number and issue date
      g. Additional information required by the applicable NFPA and IEEE standards.
      h. Labels shall be manufacturer's standard labels with quantity and mounting location per manufacturer's standard.

H. Perform a harmonic study in accordance with IEEE 519 from the 12470V level (with close coordination with the utility's upstream 12470V protective devices) through the 208/120V subsystem level equipment and devices of the proposed Wild Horse Wastewater Treatment Plant. In the studies, include the previously mentioned Thevenin equivalent system characteristics for the 12470V system provided by the utility. Including all necessary equipment (motor control center, switchboard, panelboard, transformer, feeders, loads, power factor correction capacitors, etc.) as required to demonstrate compliance with the harmonic performance requirements of IEEE 519 at the point of common coupling with Bluebonnet Electric, as well as the additional locations as defined on the PLANS, and associated recommendations. Refer to the PLANS. Include effort to adjust filter sizes (as applicable) and determine optimal VFD settings in accordance with the actual installed equipment

I. THE ARC-FLASH STUDIES, THE SHORT CIRCUIT CALCULATIONS AND ANALYSIS, THE COORDINATION STUDY, AND THE MOTOR STARTING STUDIES, AND HARMONIC STUDY SHALL BE PERFORMED:
   1. UTILIZING SKM SOFTWARE, LATEST RELEASE – MICROSOFT WINDOWS VERSION. In addition to the hard copy submittal, an electronic copy of the FINAL VERSION of the short circuit analysis/calculations and the protective device setting curves (time-current curves) and summary setting

tables, etc. shall be submitted on a Universal Serial Bus (USB) external flash drive.

2. By a State of Texas Registered Professional Engineer. The final version of the studies shall be signed and sealed by a Professional Engineer who is Licensed in the State of Texas as an Electrical Engineer.

PART 2 PRODUCT

2.01 GENERAL

A. For additional construction notes and special requirements, refer to the PLANS. Also refer and adhere to the requirements of the PLANS.

B. SWBD shall not exceed the dimensions shown on the PLANS. Compartment/component arrangement shall be as shown on the elevation drawings. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below, as shown on the PLANS.

2.02 CONSTRUCTION

A. Structure
   1. Enclosures shall be NEMA Type 1, Gasketed. Enclosure shall be the totally enclosed, dead front, free standing type suitable for back-to-wall mounting. SWBDs shall be FRONT ACCESS ONLY. SWBDs shall be front and rear aligned.
   2. SWBD shall consist of required number of vertical sections bolted together to form a rigid self support assembly. Each vertical section shall be nominally 90 inches high. Each vertical section shall be subdivided into compartments. Refer to the PLANS for additional dimensional requirements.
   3. Each vertical section may be rolled, moved, or lifted into position.
   4. All SWBD sections shall have open bottoms and field removable top plates.
   5. A hinged door shall be provided for each of the following compartments:
      a. Metering compartment
      b. Incoming line section compartment.
   6. SWBD shall comply with UL Service Entrance requirements for SWBDs.
   7. Unused spaces in each vertical section shall be covered by blank covers.
   8. Unused structure openings shall have plugs or covers to prevent entry of foreign objects into the SWBD.
   9. Structure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer's standard.
   10. Provide each vertical section with a space heater wired to terminal blocks in the respective section. Size the space heater per manufacturer's standard.
   11. Structure shall include field removable lifting means.
   12. Incoming line section shall include lugs for the connection of the field wiring shown on the PLANS.

B. Buses
   1. All buses shall be tin plated copper.

2. The main horizontal bus shall extend the entire length of the SWBD. Buses shall be fully rated and the rating shall be based on 65 degrees C maximum temperature rise in a 40 degree C ambient. The main bus shall be rated as shown on the PLANS and/or data sheets. Provisions shall be provided to facilitate future extension of the buses.
3. The minimum RMS symmetrical short circuit current rating of the buses shall be as indicated on the one-line diagram drawings.
4. A continuous ground bus shall be furnished for the entire length of the SWBD. The ground bus shall be rated for 50 percent of the main horizontal power (phase) bus rating, at minimum. Stack multiple ground bus bars as required to provide the required ground bus rating. Provide ground bolted connectors for the size and quantity of wire at each end of the bus as shown on the PLANS.

C. Wiring
1. Control and/or discrete signal wiring includes wiring to instrument current transformers, 600 volt wiring to secondary of instrument potential transformers, ammeters, power monitoring units “PMU’s”, lights, receptacles, control relays, control devices (pilot lights, selector switches, etc.), relaying etc. Control wiring shall be extra flexible 41 strand, tin-plated copper, 600 volt insulation, dual rated type XLPE (3173) 125° C, SIS 90° C., SIS wire manufactured by General Cable Company, The Okonite Company or approved equal. Minimum acceptable size to be #14 AWG.
2. Instrument signal wiring shall be twisted pair, #16 AWG stranded copper conductors with 600 volt PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum mylar shield and an outer PVC jacket. Instrument wiring cables shall be manufactured by “Samuel Moore and Company, DeKoron Division, Cat. No. 1852”. All instrument signal wiring shall be installed and tested at the factory.
3. All control/metering wiring shall be neatly bounded with tie-wraps and supported to wire ways supports.
4. Control/metering wiring shall be terminated to terminal blocks.

D. Identification
1. All component and control identification labels shall include the device name and number exactly as it appears on the PLANS. Refer to the PLANS.
2. All control/metering wires shall be tagged and coded with an identification number. Tagging type and wire coding shall be per manufacturer’s standard.
3. All terminal blocks shall be identified.
4. Properly label the control/metering devices mounted inside the each section using manufacturer’s standard laminated labels installed in accordance with the manufacturer’s standard method. Minimum text height shall be 3/16 inch.
5. Nameplates:
   a. Type: 3-ply, 1/8” thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   b. Color: White-Black-White
   c. Lettering: Engraved through the face layer to the melamine middle layer. Nameplates located on the face of each section/compartment of each

Switchboard shall be legible at a distance of six feet from the nameplate. Minimum text height shall be 3/16 inch.

d. Accessories: Provide holes for mechanical fastening
e. Attachment Means: Secured with two Stainless Steel screws/bolts per manufacturer's standard; use of adhesives shall not be accepted.

6. Furnish and install nameplates for:
   a. Each equipment/device/etc. installed/mounted on the face of the SWBD.
   b. Each exterior section/compartment of each SWBD.
   c. Overall entire lineup of SWBD, i.e. a master nameplate. Master nameplate shall include the tag of the SWBD as shown on the PLANS, at minimum, in addition to manufacturer's standard information for master nameplates.

2.03 MAIN AND TIE CIRCUIT BREAKERS AND AUTOMATIC TRANSFER SWITCH FEEDER CIRCUIT BREAKERS

A. Rating: Circuit breaker shall be three pole, 600V with a maximum continuous current carrying capacity shown on the PLANS and a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than 42,000 amperes at 480V A.C. Breaker shall be U.L. listed and comply with NEMA Standard No. AB1-1975 and Federal Specification W-C-3758/GEN 21a. Circuit breaker shall be fully rated and not require rating for ambient temperatures 40 degrees Celsius or less.

B. The circuit breakers shall be fixed mounted power operated. The breakers shall be operated by a motor charged stored energy spring mechanism, charged normally by a universal electrical motor, remotely operated from the Distributed Control System, and in an emergency by a manual handle. The primary disconnecting contacts shall be tin-plated copper. The breaker shall include a provision for padlocking open to prevent manual or electric closing. The padlocking shall also secure the breaker in the connected test, or disconnect position by preventing levering. The circuit breaker shall be manufactured by "Square D" model "Masterpact NW Series" or approved equal.

C. The circuit breakers shall be furnished with the following accessories and options:
   1. Shunt Trip Device
   2. Shunt Close Device
   3. Ready-to-Close Contact
   4. Electrical Closing Pushbutton
   5. Auxiliary Position Switches
   6. Overcurrent Trip Switch
   7. Micrologic Trip Unit Accessories: Circuit breakers shall have an electronic trip (solid state) unit. Trip unit shall be solid state with adjustable long time, short time, instantaneous with ground fault and pick up settings, "Square D" – model Micrologic Trip Unit with Harmonic Metering with specified accessories, with the shunt Trip Unit Attachment, and Internal Ground Fault Protection, or approved equal. Construction shall allow connection of supply conductors at either end.
      a. External Neutral Current Transformer
      b. Metering current Transformers
      c. Voltage Measurement Inputs
      d. Sensor Plugs

e. Adjustable Rating Plugs
f. External Power Supply Module
g. External Battery Backup Module

8. Mechanical operations counter to record the number of circuit breaker operations.

D. The 120VAC source for each MAIN and TIE circuit breaker and each AUTOMATIC TRANSFER SWITCH feeder circuit breaker shall be supplied from a dedicated control power transformer internal to the MCC assembly and connected to the line side of the circuit breaker terminals. The control power transformer(s) shall be provided with fused primary windings and fused secondary windings as specified hereinafter. The Manufacturer shall size the control power transformer, fuses and related interconnect wiring.

E. Provide each circuit breaker with the following 120VAC operators: REMOTE OFF-REMOTE ON selector switch. Selector switch shall be as specified in Section 17200 "Instrumentation and Control Cabinets and Associated Equipment". All breaker control devices shall be wired in accordance to the manufacturer's standard control wiring diagram for power operated circuit breakers. Wire an additional REMOTE OFF-REMOTE ON selector switch contact to control wiring terminal blocks located within the breaker unit compartment indicating that the selector switch is in the "REMOTE ON" position. The selector switch will be monitored by the Distributed Control System as shown on the PLANS.

F. Each circuit breaker shall be furnished with Normally Open (N.O.) and Normally Closed (N.C.) auxiliary breaker status contacts that will change state when the breaker is opened and/or closed. The auxiliary breaker status contacts shall be rated 5-amps at 120VAC. Pre-wire both status contacts to the control wiring terminal blocks located within the breaker unit compartment to be monitored by the Distributed Control System as shown on the PLANS.

G. Provide each circuit breaker with the components required to comply with the Main and Tie Circuit Breaker Control Wiring Schematics and the Automatic Transfer Switch Feeder Circuit Breaker Control Wiring Schematics shown on the PLANS.

H. Terminations: Breakers shall have removable lugs, U.L. listed for copper and aluminum conductors and U.L. listed for installation of mechanical screw type lugs.
1. Lugs shall be able to accept the quantity of parallel conductors per phase and the size conductor shown on the PLANS. Refer to the PLANS.

2.04 FEEDER CIRCUIT BREAKERS

A. Provide thermal magnetic molded case circuit breakers with the following minimum requirements:
1. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the main bus.
2. Circuit breaker shall be three pole, 600 volt with a maximum continuous current carrying capacity shown on the PLANS.
3. Breakers shall operate continuously when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers.

4. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
5. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
6. Provide mechanical padlock attachment for each circuit breaker.
7. Furnish lugs for feeders where required to facilitate field wiring termination, sizes shall be as required by the PLANS.

B. All branch circuiting circuit breakers shall be group mounted.

C. Provide where specifically shown on the PLANS:
1. Current limiting circuit breaker
2. Electronic trip attachment. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings.
3. Auxiliary contacts rated for 120 volts A.C. Contacts shall satisfy the requirements of the PLANS.

2.05 SURGE PROTECTION DEVICE

A. Provide Surge Protective Device (SPD) system were required by the PLANS. The SPD shall have the following characteristics:
1. SPD shall be tested with the ANSI/IEEE Category C high exposure waveform of 10 kA for 8 x 20 microseconds, at minimum.
2. Integrated surge protective device recognized in accordance with UL 1449.
3. Minimum surge current withstand shall be 160 kA per phase (80 kA per mode)
4. Has a minimum pulse life of 5000 ANSI/IEEE Category C high transients without failure or degradation of clamping voltage by more than 10 percent.
5. Provide with manufacturer's standard line side disconnect.
6. Provide visual indication of SPD status.
7. Surge counter.
8. Provide dry contact failure status output contact. Contact shall be rated for 120 volts A.C. and shall satisfy the requirements of the PLANS.
9. 5 year warranty, at minimum.

2.06 CONTROL POWER TRANSFORMERS AND MISCELLANEOUS ACCESSORIES.

A. Provide control power transformer, fuses, power supplies, etc., and associated interconnect wiring as required to provide functional control power service to the circuit breaker trip circuitry for proper operation of circuitry, per manufacturer's standard.

B. SWBD Space Heater control power transformer for the SWBD, where required by the PLANS, shall have the following characteristics:
1. Adequately sized to drive the entire space heater circuitry of the SWBD and the associated close-coupled MCC. Refer to the requirements specified in Section 16120 "480 Volt Motor Control Centers", paragraph 2.08 D.
2. 120 volt AC grounded secondary
3. Connect as shown on the PLANS.

4. The space heater of each vertical section of the SWBD and associated close-coupled MCC shall be individually protected with a fuse mounted in the control power transformer compartment.
5. The space heater circuitry shall be thermostatically controlled by centrally located thermostat(s). Provide the quantity of thermostats necessary to serve the load of the space heater circuitry.

C. Patch Panel: Where patch panel shown on the PLANS, furnish and install a dedicated patch panel for termination of the Ethernet data highway (serial communication) cabling for each Power Metering Unit (PMU) and Protective Relay. Patch panels shall be two-port, DIN-rail mounted, module type, with side lids, Category 6A, as manufactured by "Signamax" KI-DIN-RMM-SL Keystone Industrial DIN-Rail Mounting Module for Keystone Jacks. Furnish patch panel complete with two (2) blue, RJ-45 keystone jacks manufactured by "Signamax" Category 6A MT-Series High Density Keystone Jacks. Label each port with printed minimum 1/4" high lettering using indelible moisture and heat resistant marking system, black on white. In addition, label the overall patch panel with tag using phenolic tagging. Secure Din-rail to backpanel with screws. Ethernet patch cords shall be furnished and installed between the patch panel and the respective protective relay/power monitoring unit per the requirements of Section 17600 "Distributed Control System".

D. Provide key interlocks where required by the PLANS.

E. Lightning and Surge Arresters:
1. Provide station class (type), 3-phase, rated 600 volts lightning arresters where shown on the PLANS. Lightning arresters shall be U.L. listed and certified, valve type, and shall be designed and manufactured in accordance with the latest revision of ANSI/IEEE C62.11.
2. Provide 3-phase surge capacitors where shown on the PLANS. Surge capacitors shall be U.L. listed and certified, and non-PCB type.

2.07 INSTRUMENT TRANSFORMERS

A. General:
1. All instrument transformers specified shall be installed and connected at the factory.

B. Instrument current transformers (C.T.'s):
1. Provide current transformers where required by the PLANS. Connect as shown on the PLANS.
2. Current transformers shall be the window type and shall have an ANSI 60 Hz Metering Accuracy Class of 0.3 measured at burden of B0.1, at minimum.
3. Install a shorting terminal block for each current transformer (C.T.). Prewire all terminals of each C.T. to its respective shorting terminal block. Shorting terminal blocks shall be as manufactured by "G.E.", or approved equal.

C. Instrument Potential Transformers (P.T.'s):
1. Provide potential transformers where required by the PLANS. Connect as shown on the PLANS.
2. Potential transformers shall have the following characteristics:
a. Primary voltage: 480 volts AC

b. Secondary voltage: 120 volts AC
c. Accuracy rating: 0.6 Y at burden of 1.2X
d. Thermal Burden: 150 VA at 30 degrees C ambient
e. Frequency: 60 Hz

3. Install with primary and secondary disconnect devices, grounding device, and accessories in conformance with IEEE and NEMA standards.
4. Provide current limiting type primary fuses.

2.08 METERING AND POWER MONITORING UNIT "PMU" FOR SWITCHBOARD

A. Where required by the PLANS, furnish and install a Power Metering Unit (PMU). The PMUs shall be as manufactured by General Electric - MULTILIN Model EPM 9700 (Transducer Module) with advanced software option complete with three line LED combination display and keypad Model P40NPLUS, with the Ethernet communication capability, harsh environment UL 746C/94 recognized conformal coating on all printed circuit assemblies and all required interconnect cabling as also shown on the PLANS, No Equal. Units shall be connected as shown on the PLANS.

B. Additional Requirements for the PMU:
1. Furnish and install an Ethernet connection to the PMU on the Switchboard compartment door adjacent to the PMU LED display for accessing PMU settings files.
2. Where shown on the PLANS, furnish and install a patch panel in accordance with the requirements of Sub-Section 2.05 C, this Section of the Specifications.

2.09 METAL ENCLOSED OVERHEAD BUS DUCT

A. Furnish and install metal enclosed bus duct were required by the PLANS. The overhead bus duct shall have the following characteristics:
1. All buses shall be tin plated copper.
2. All buses shall be insulated with manufacturer’s standard insulation.
3. Buses shall be fully rated and the rating shall be based on 55 degrees C maximum temperature rise in a 40 degree C ambient. The bus continuous current rating shall be the same as the SWBD main bus, as also shown on the PLANS.
4. The minimum RMS symmetrical short circuit current rating of the buses shall be as indicated on the one-line diagram drawings.
5. Dedicated continuous ground bus shall be furnished for the entire length of the bus duct. The ground bus shall be rated for 50 percent of the main power (phase) bus rating, at minimum.
6. The bus duct shall have the “sandwich” type configuration with no air gap between bus bars.

B. Bus duct enclosure shall have the following characteristics:
1. Totally enclosed, non-ventilated, suitable for indoor use.
2. Fabricated from aluminum or steel per manufacturer’s standard.
3. Finish shall be primed and painted using the manufacturer’s standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer’s standard.

C. Provide with all necessary joints, fittings, covers, adapters, hardware, etc., as required for a complete and functional bus duct installation. This shall include, but not be limited to:
   1. Elbows, flanges, TEE fittings,
   2. Flexible connectors,
   3. All necessary covers for openings,
   4. Thermal expansion fitting when bus duct crosses a building expansion joint. Refer to the PLANS for locations of building expansion joints.

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TEST

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

B. The Owner may elect to witness the factory tests as outlined above. The manufacturer shall provide at least three (3) week notice prior to the date the tests are to be performed.

3.02 FIELD INSTALLATION

A. Install per manufacturer's instructions and recommendations. Install all required safety labels.

B. Perform manufacturer's field services as previously specified.

C. Coordinate sizing of the wireway/plenum/pullbox enclosures with the SWBD manufacturer.

3.03 FIELD TEST AND CHECKS

A. The following minimum test and checks shall be made before energizing the SWBDs and associated bus duct system. These tests shall be performed by a Factory Trained Field Technician (non sales type):
   1. Thoroughly inspect the SWBD and bus duct system.
   2. Test for proper phasing of power connections. Additionally, check phasing across the SWBDs and connecting overhead bus duct/tie feeders (as applicable) using phasing sticks.
   3. Set, adjust, and test all protective relays based on the results of the coordination study, refer to sub-section 1.08, this Section of the Specifications.
   4. Megger terminals and buses for grounds, test per manufacturer's recommendations.
   5. Verify ratios of all CT's, and proper operation of all metering.
   6. Verify SWBD enclosure space heater circuits are operational.
   7. Test key interlock system for proper functionality.

8. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

B. Submit documentation of all tests outlined above.

C. Submit manufacturer’s certification report per sub-section 1.12, this Section of the Specifications.

3.04 EQUIPMENT PROTECTION AND RESTORATION

A. Clean and vacuum clean all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

C. Remove all current transformer shunts after completing secondary circuit.

D. Energize the space heaters within the SWBD and energize during storage and installation for humidity control.

3.05 TRAINING

A. Provide training sessions for owner’s representatives for One (1) FULL normal workday at the job-site location and/or at a location determined by the OWNER. If training is conducted in less than the time required by these specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the SWBD manufacturer’s non-sales-type technical representative, who performed the field installation and start-up/setting/adjustment services.

C. At minimum, the training session shall include:
   1. Operation and maintenance procedure for the equipment and all components installed within the SWBDs.
   2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.

D. Training session may be concurrent with the training session for the 480 Volt Motor Control Centers specified in Section 16120 “480 Volt Motor Control Centers”, Subsection 3.05.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

PART I - GENERAL

1.01 SUMMARY

This section specifies raceways, fittings, and supports for all cables, conductors and electrical equipment. The CONTRACTOR shall furnish and install complete raceway systems in accordance with the following specifications.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced and shall apply as if written here in their entirety. The publications are referred to in the text by basic designation only.

1. ANSI C80.1 Electric Rigid Steel Conduit
2. ANSI C80.5 Electrical Rigid Aluminum Conduit
3. ETL-PVC-001 Edison Testing Lab Polyvinyl Chloride
4. NEMA 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)
5. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
6. NEMA TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
7. NEMA TC 14 Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
8. NFPA 70 National Electrical Code (NEC)
9. NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities
10. UL 651 Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
11. UL 2515 AG Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
12. UL 2420 BG Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
13. UL7 514B Conduit, Tubing, and Cable Fittings

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 01300.

1.07 – 1.10 (NOT USED)

1.11 OPERATION AND MAINTENANCE MANUALS

A. Operations and Maintenance (O&M) Manuals are not required for materials covered under this Section.

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. Exposed-Outdoor and Non-Chemical Areas Above Ground Level

1. Rigid Aluminum Metal Conduit System

a. Conduit run above ground shall be U.L. listed 99% copper free rigid aluminum and meet the requirements of ANSI C80.5. Conduit pipe straps and hardware to be 316 stainless steel. Conduit shall be manufactured by Allied Company, or approved equal.

b. Minimum above grade conduit size for all work shall be 3/4-inch.

2. Conduit Seals

a. Conduit seals to be suitable for use in class-I, group B, C, and D, and class-II group F and G. Conduit seals shall also meet or exceed the following minimum requirements:

b. Seal body, nipples and closures shall be 99% copper-free aluminum. Seal bodies shall be filled with 3M 2123 Re-Enterable Sealing Compound.

1) Class 1, Division 1 areas shall be sealed per NEC requirements.

c. Drain: Stainless steel

d. Removable Nipples: 99% copper-free aluminum

e. Conduit seals to be manufactured by Crouse-Hinds type EYS drain seals with specified options, or approved equal.

f. Seals to be installed directly adjacent to, and, just immediately before entering wet well junction box. See details on drawings.

3. Conduit Hubs

    a. Conduit hubs shall be the grounding type, 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by Myers, or approved equal. Conduit hubs shall be furnished complete with rubber gasket.

4. Grounding Bushings

    a. Conduit grounding bushing shall be 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by Meyers type STAG, or approved equal.

5. Conduit Bodies

    a. All conduit bodies shall be 99% copper-free aluminum. Conduit bodies shall be manufactured by Crouse-Hinds Form 7, or approved equal.

6. Conduit Body Covers

    a. Conduit Body Covers shall be die cast aluminum with 316 stainless steel screws. Snap on covers are unacceptable. Supply separate gaskets with all covers.

7. Conduit Unions

    a. Conduit unions shall be threaded, 99% copper-free aluminum. Conduit unions shall be manufactured by Crouse-Hinds type UNF or UNY, or approved equal by Appleton or O.Z. Gedney.

8. Clamp Backs

    a. Single runs of conduit may be supported with cast aluminum clamp backs with stainless steel hardware and standoffs.

9. Conduit Straps

    a. All conduit straps shall be 316 Stainless Steel unless indicated differently by the plans and or specifications.

10. Liquid Tight Flexible Conduit

    a. Liquid tight flexible conduit shall be non-metallic (NM) type liquid tight flex for sizes ¾” through 2”. For sizes 2 ½” and larger provide standard seal tight flex with aluminum core, formed from PVC plastic. Provide aluminum or nonmetallic liquid tight fittings that are suitable for installation in temperature range between -20 degrees C to +60 degrees C (suitable for use outdoors and indoors). Liquid tight flexible conduit and fittings shall be as

manufactured by "Electri-Flex" series NM type B-PVC, Thomas & Betts type LT-38P, or approved equal. ½" type NM flexible liquid tight conduit may be used for instruments having ½" threaded entry point.

b. Liquid tight flexible conduit shall be used for connections to motors, field instruments, etc., and any equipment subject to vibration, and, where shown on the drawings. Maximum length **to be 36" unless** otherwise noted on drawings or approved by the OWNER or ENGINEER.

11. Electrical Equipment and Raceways Support Channels

a. Electrical equipment and raceway support channels shall be fabricated with 316 stainless steel material manufactured by Unistrut Corporation series P-1000SS and P-1001SS, or approved equal. All fastening hardware, fittings, supports, base posts, clamps, framing system, etc. shall also be fabricated with 316 stainless steel. Manufacturer shall be Unistrut Corporation, or approved equal.

B. Exposed Chemical Areas

1. Schedule 80 PVC

a. Conduit shall be Schedule 80 PVC, U.L. rated, No. 651, conforming to NEMA standard TC-2 and listed in conformity with Article 352 of the National Electrical Code (NEC). The conduit is to be manufactured by Carlon, or approved equal. Solvent weld shall be a type approved by the conduit manufacturer.

b. Minimum above grade conduit size for all work shall be 3/4-inch.

2. Conduit Hubs

a. Conduit hubs shall be manufactured from fiberglass as manufactured by Champion, or approved equal. Conduit hubs shall be furnished complete with rubber gasket.

3. Conduit Bodies

a. All conduit bodies shall be manufactured from PVC.

4. Conduit Body Covers

a. Conduit Body Covers shall be PVC with 316 stainless steel screws. Conduit body covers shall be furnished complete with rubber gasket.

5. Clamp Backs

a. Single runs of conduit may be supported with PVC or fiberglass clamp backs and standoffs with fiberglass hardware.

6. Conduit Straps

   a. All conduit straps shall be fiberglass or PVC, unless indicated differently by the plans and or specifications.

7. Liquid Tight Flexible Conduit

   a. Liquid tight flexible conduit shall be non-metallic (NM) type liquid tight flex for sizes ¾" through 2". For sizes 2 ½" and larger provide standard seal tight flex with aluminum core, formed from PVC plastic. Provide aluminum or nonmetallic liquid tight fittings that are suitable for installation in temperature range between -20 degrees C to +60 degrees C (suitable for use outdoors and indoors). Liquid tight flexible conduit and fittings shall be as manufactured by Electri-Flex series NM type B-PVC, Thomas & Betts type LT-38P, or approved equal. ½" type NM flexible liquid tight conduit may be used for instruments having ½" threaded entry point.

   b. Liquid tight flexible conduit shall be used for connections to motors, field instruments, etc., and any equipment subject to vibration, and, where shown on the drawings. Maximum length **to be 36" unless** otherwise noted on drawings or approved by the OWNER or ENGINEER.

8. Supporting Hardware and Brackets

   a. All support channels shall be manufactured from fiberglass.

   b. All fastening hardware shall be suitable for chemical area, or as approved by the ENGINEER/OWNER.

C. Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete

1. Schedule 40 PVC

   a. Conduit run underground in duct bank system shall be Schedule 40 PVC, U.L. rated No. 651, conforming to NEMA standard TC-2 and listed in conformity with Article 352 of the National Electrical Code (NEC). The conduit is to be manufactured by Carlon, or approved equal. Solvent weld shall be a type approved by the conduit manufacturer.

   b. Minimum conduit size for all underground work shall be 1-inch.

2. PVC Coated Galvanized Rigid Steel Conduit

a. PVC coated RGS conduit shall be coated with a 40 mil exterior coating of PVC and a 2 mil urethane interior coating. The coating system shall be in compliance with ETL PVC-001. Refer to Part 3-Execution of this Section, and to details provided on the contract drawings. PVC Coated Rigid Galvanized Steel conduit shall be Plasti-Bond REDH2OT or Perma-Cote coated conduit as manufactured by Rob Roy. A manufacturer's installer certification shall be required for electricians installing the PVC coated RGS conduits.

b. Minimum conduit size for all underground work shall be 1-inch.

3. Reinforced Thermosetting Resin Conduit (RTRC)

a. RTRC shall be Champion HAZ DUCT XW Type fiberglass conduit or approved equal.

b. The use of RTRC shall conform to Article 355 of the National Electric Code (NEC).

c. Installation of conduit, including field bends, shall be done so ONLY in accordance with the manufacturer's installation instructions.

d. Fittings

1) 90 degree bends with factory installed 2 deep socket PVC coupling and 1 fiberglass coupling bonded to elbow

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-90-2DF**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-90-2DF**

2) Sleeve Couplings

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-42**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-42**

3) Female Terminal Adapters

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-32**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-32**

4) Straight Socket Conduit

I. For 3/4" – 1 ½", use type IPS (NOTE: Minimum conduit size for all underground work shall be 1-inch)

i. Example part number for 1": **10C-XW-10S**

II. For 2" – 6", use type ID

i. Example part number for 2": **20D-XW-20-S**

e. Champion Mix Epoxy Adhesive

1) For ambient temperatures 40 - 70 degree F, use type **CM-2040-SFG**

2) For ambient temperatures 70 degree F and above, use type **CM-2070-SFG**

f. Champion Mix Epoxy Adhesive Mixing Tip and Gun

1) Mixing Tip: **CM-MT**

2) Mixing Gun: **CM-AG**

g. A manufacturer's installer training course shall be required for electricians installing the RTRC.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Install electrical equipment and raceway system conduit in accordance with the recommendations of the manufacturer, the requirements of the National Electrical Code (NEC), local codes, and the contract drawings and these specifications.

B. Use only persons skilled and licensed in the State of Texas to perform this type of work.

3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Exposed-Outdoor and Non-Chemical Areas Above Ground Level

1. Utilize 316 stainless steel support channels to install raceways, and any other surface mounted electrical, instrumentation and control equipment. Refer to details shown on the contract drawings.

2. All mounting hardware and straps shall be 316 stainless steel.

3. Run exposed conduit parallel or at right angles to building lines.

4. Secure conduits to all cabinets and boxes with specified hubs and bonding jumpers in such a manner that each system is electrically continuous throughout.

5. Install all conduits as a complete system before wiring is pulled in. Conduits shall be reamed and swabbed clean immediately before wiring is pulled in.

6. Cap conduits during construction to prevent entrance of dirt, trash, and water.

7. Equip conduit across structural joints, where structural movement is allowed with an O.Z./Gedney, or equal, 99 % aluminum expansion fittings of that conduit size.

8. Conduit nipples shall have two independent sets of threads. Running threads shall not be used. Where conditions require joining two fixed conduits into a continuous run, a conduit union shall be used.

9. Coat all conduit threads with **LOCTITE LB 8014 Food Grade Anti-Seize or approved equal.**

10. Maintain 6-inch clearance between conduit and piping and 12-inch clearance between conduit and heat sources such as flues, steam pipes and heating appliances.

11. Arrange conduits to maintain headroom and present a neat appearance.

12. Conduits run above ground shall be supported at least every 10-feet and once in every change in direction and at the end of each straight run terminating in an enclosure and within three feet of every junction box.

13. Secure conduit runs firmly to specified support channels by stainless steel conduit straps or by hangers, as required.

14. Rigid conduit joints to be cut square, threaded, reamed smooth and drawn up tight. Bends or offsets to be made with standard conduit ells. Make field bends with an approved bender or hickey or hub type conduit fittings. Conduit shall contain no more than the equivalent or three (3) 90-degree bends between outlets or fittings.

B. Exposed Chemical Areas

1. Run exposed conduit parallel or at right angles to building lines.

2. Secure conduits to all cabinets and boxes with specified hubs and bonding jumpers in such a manner that each system is electrically continuous throughout.

3. Install all conduits as a complete system before wiring is pulled in. Conduits shall be reamed and swabbed clean immediately before wiring is pulled in.

4. Cap conduits during construction to prevent entrance of dirt, trash, and water.

5. Equip conduit across structural joints, where structural movement is allowed with PVC expansion fittings of that conduit size.

6. Maintain 6-inch clearance between conduit and piping and 12-inch clearance between conduit and heat sources such as flues, steam pipes and heating appliances.

7. Arrange conduits to maintain headroom and present a neat appearance.

8. Conduits run above ground shall be supported per NEC requirements based on conduit size, at every change in direction and at the end of each straight run terminating in an enclosure and within 12-inches of every junction box.

9. Secure conduit runs firmly to specified support channels by fiberglass conduit straps or by hangers, as required.

10. Conduit shall contain no more than the equivalent or three (3) 90-degree bends between outlets or fittings.

11. NEC approved bender is required for bending PVC conduit. Open flame is not allowed.

C. Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete

1. Install Schedule 40 PVC conduit underground in steel reinforced duct banks changing to PVC coated rigid galvanized steel conduit at the final factory 90-degree bend, transitioning from underground to the above ground conduit system.

2. The transition from PVC coated RGS to aluminum rigid shall be made at a minimum of six (6) inches above finished slab and/or housekeeping pad. Duct bank concrete shall extend six (6) inches above finished grade at all outdoor locations.

3. Duct banks and/or conduit banks shall be continuously reinforced along the entire length utilizing No. 4 stirrups at 1'-6" spacing and No. 5 longitudinal bars at all four corners, at a minimum. Provide 1'-6" overlap splices on all longitudinal bars.

4. Conduit support chairs shall be spaced at 5'-0" minimum spacing.

5. Duct banks shall be encased in red concrete to its final destination even when routed under building/structure, concrete floor slab, and/or equipment concrete/housekeeping concrete pad. Rebar shall be kept a minimum of two (2) inches off of the ground to allow complete concrete coverage. Concrete shall be 3000 psi. A red add mixture, HBS #120 Conduit Red as manufactured by ChemSystems, Inc., or equal, shall be added to the concrete at a minimum of 12 pounds per cubic yard of concrete. Forms shall be used unless the trench wall is stable enough to support the concrete.

    a. All form boards shall be removed after concrete has been poured and set.

    b. Stay-form may be used in lieu of form boards. Minimum clearance between form and reinforcing steel is maintained and the Stay-form does not tie to the duct bank rebar.

6. Cap conduits during construction to prevent entrance of dirt, trash, and water.

7. Provide a minimum of 2-inches separation utilizing Plastic conduit chairs between conduits installed in concrete duct bank. Spacing may be less at panel boards, pull or junction boxes or other locations where the conduits have to be grouped.

8. The minimum depth of a duct bank is twenty-four (24) inches to the top of the Concrete.

9. Duct bank conduits shall have a minimum of three (3) inches per 100-feet slope from the high point toward the manholes.

10. All underground conduit joints shall be waterproofed in accordance with the manufacturer's recommendations

11. Backfilling shall be done in such a manner that voids will be minimized. Compact backfill so that it is the same density as the surrounding soil. Excess soil shall be piled on top and shall be well tamped. All rock and debris greater than one (1) inch in size shall be removed from the site.

12. Conduits joints to be staggered a minimum of six (6) inches.

13. Where a duct bank penetrates or turns up next to a structure, dowel rebar a minimum of four (4) inches into the structure at the point of connection/intersection tying the steel reinforcing of the duct bank to the structure at a minimum of four locations.

14. All duct banks shall be placed under building slab (not in building slab) with longitudinal duct bank steel reinforcement tied to building slab steel reinforcement with an 18-inch overlap.

15. Conduits shall penetrate building slab at 90-degrees and shall run in duct banks under building slab and not run parallel though building slabs.

16. NEC approved bender is required for bending PVC conduit. Open flame is not allowed.

17. Polyethylene Warning Tape

    a. Warning tape shall be red metal detectable polyester, 6-in minimum width.

    b. Warning tape legend shall read: “CAUTION: BURIED ELECTRIC LINE BELOW”.

    c. Contractor shall place tape 6” below grade on all buried electrical duct banks or as shown on the PLANS.

18. Hand holes and Manholes

    a. All hand holes and manholes (cast-in-place and pre-cast) shall have a solid bottom unless otherwise noted on the drawings.

    b. Hand holes are not required to be grounded unless otherwise noted on the drawings.

D. Conduit Penetrations:

1. Use 3M 20mil corrosion tape to protect raceways for penetrations through walls, floors, and block outs and grout once work is complete. The tape should extend six (6) inches beyond the walls or floors.

2. Link-Seal modular seals shall be used for all subgrade conduit penetrations.

3. PVC pipe shall be used for all pour-in-place concrete conduit penetrations.

4. Penetrations made through fire-rated walls or floors of buildings shall be sealed with appropriate fire-stop material/product as manufactured by Nelson Flameseal or approved equal.

E. Miscellaneous:

1. Seal empty spare conduits (at above ground stub-ups) with an all-solid aluminum washer sized to the trade size (outer diameter) of the conduits.

2. Seal and pack/fill ends of each conduit with fire-retardant and waterproof conduit/duct sealant as manufactured by Nelson Flameseal or approved equal.

3. In all sealing fittings, utilize 3M Company 2123 Re-Enterable Sealing Compound to seal around and between each conductor and associated fitting body.

3.04 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

A. No separate payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SPECIAL PROVISION To

Standard Specification Item No. 16150 (Version 09/24/2019)
Raceways, Fittings and Supports

For this project Item No. 16150 Raceways, Fittings and Supports of the Austin Water Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the Austin Water Standard Specifications are waived or changed.

1. ADD the following sub-sections to PART II – PRODUCTS:

2.02 MATERIALS/CONSTRUCTION

A. Exposed-Outdoor and Non-Chemical Areas Above Ground Level
   1. Rigid Aluminum Metal Conduit System
      c. Bending Requirements: Furnish factory long radius of curvature bends for changes in direction for all conduits. Bends of conduit sizes equal to or greater than 4-inches in diameter shall have a minimum bending radius of 48-inches unless otherwise noted on the PLANS. Bends of conduit sizes less than 4-inches in diameter, shall be per manufacturers standard unless otherwise noted on the PLANS.

2.02 MATERIALS/CONSTRUCTION

A. Exposed-Outdoor and Non-Chemical Areas Above Ground Level
   12. Cord and Cable Fittings:
      a. Provide threaded gland nut, straight threaded body, and also a neoprene sealing cable bushing.
      b. Furnished with a Type 316 Stainless Steel wire mesh grip
      c. Shall be used only where specifically shown on the PLANS.
      d. Manufacturer: “Crouse-Hinds” type CGB, complete with all specified accessories, or approved equal.

2.02 MATERIALS/CONSTRUCTION

B. Exposed Chemical Areas
   1. Schedule 80 PVC
      c. Bending Requirements: Furnish factory long radius of curvature bends for changes in direction for all conduits. Bends of conduit sizes equal to or greater than 4-inches in diameter shall have a minimum bending radius of 48-inches unless otherwise noted on the PLANS. Bends of conduit sizes less than 4-inches in diameter, shall be per manufacturers standard unless otherwise noted on the PLANS.

2.02 MATERIALS/CONSTRUCTION

C. Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete
   1. Schedule 40 PVC
      c. Bending Requirements: Furnish factory long radius of curvature bends for changes in direction for all conduits. Bends of conduit sizes equal to or greater than 4-inches in diameter shall have a minimum bending radius of 48-inches unless otherwise noted on the PLANS. Bends of conduit sizes less than 4-inches in diameter, shall be per manufacturers standard unless otherwise noted on the PLANS.

2.02 MATERIALS/CONSTRUCTION

C. Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete
   2. PVC Coated Galvanized Rigid Steel Conduit
      c. Bending Requirements: Furnish factory long radius of curvature bends for changes in direction for all conduits. Bends of conduit sizes equal to or greater than 4-inches in diameter shall have a minimum bending radius of 48-inches unless otherwise noted on the PLANS. Bends of conduit sizes less than 4-inches in diameter, shall be per manufacturers standard unless otherwise noted on the PLANS.

2.02 MATERIALS/CONSTRUCTION

C. Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete
   3. Reinforced Thermosetting Resin Conduit (RTRC)
      d. Fittings
         5) Bending Requirements: Furnish factory long radius of curvature bends for changes in direction for all conduits. Bends of conduit sizes equal to or greater than 4-inches in diameter shall have a minimum bending radius of 48-inches unless otherwise noted on the PLANS. Bends of conduit sizes less than 4-inches in diameter, shall be per manufacturers standard unless otherwise noted on the PLANS.

2.03 MISCELLANEOUS

E. Polyurethane foam duct sealant: FST-250 and FST-MINI Duct Sealant as manufactured by “Polywater”, or approved equal

F. Conduit Sleeves:
   1. Conduit sleeves shall be schedule 80 PVC, heavy wall, U.L. rated, No. 651, conforming to NEMA standard TC-2-75 and listed in conformity with Article 352 of the National Electrical Code (NEC).

G. Conduit Hole Seals:
   1. Hole seals shall be stainless steel, U.L. listed as NEMA 4X oil-tight, complete with oil-resistant gasketing, backplate, stud and wing nut. Hole seals shall be manufactured by Hoffman, Rittal, Cooper B-Line, or approved equal.

2.04 MANHOLES AND HANDHOLES

A. Refer to the PLANS and Specifications for manhole requirements.

B. General requirements for Handholes:
   1. Vault shall consist of a 2-1/2" high base, 14" high body and 10" high extension(s) (quantity as required), all constructed of precast reinforced concrete.
   2. Cover shall be a bolt-down, traffic rated type constructed of galvanized steel and marked with either the word ELECTRIC or the word COMMUNICATION, as applicable.
   3. Handhole shall be a 30" x 48" Telephone Box Model C-3185 manufactured by Brooks, or approved equal, with accessories specified.

C. Provide all cable pulling eyes, cable support system components and accessories indicated on the PLANS and as otherwise required. Arrange support systems so that each cable can be securely anchored.

D. The manhole structural wall opposite each duct bank penetration into the manhole shall be equipped with a cable pulling eye (one cable pulling eye per each duct bank penetration into the manhole). Position each pulling eye with coordinates (vertical elevation and horizontal alignment) to accommodate cable pulling and minimize cable pulling tension. Pulling eyes shall be bonded to the manhole wall structural reinforcement prior to pouring concrete. Pulling eyes may not be shown on the manhole vault structural PLANS, however, they are to be installed per the requirements of this specification.

2.05 CABLE SUPPORT SYSTEM IN UNDERGROUND ELECTRICAL MANHOLES AND HANDHOLES

A. General Requirements for support channels:
   1. Type: Type 316-Stainless Steel
   2. Manufacturer: "Unistrut Corporation" series P-1000ST and P-1001ST, or approved equal.

B. All fastening hardware, fittings, supports, post bases, conduit clamps, beam clamps channel nuts, threaded rod, framing system, etc. shall be fabricated with Type 316 stainless steel, as manufactured by "Unistrut Corporation", or approved equal. Additionally, the following designations correspond to the following "Unistrut Corporation" series numbers as used in the details shown on the PLANS:
   1. Porcelain Clamps and Saddles-"Unistrut Corporation P1787A through P1795B Porcelain Cable Clamps", for both Electric and Communications and Instrumentation and Control.
   2. Surface Mounted Vertical Channels (Columns)-"Unistrut P-1000ST Type 316 stainless steel channels and accompanying Unistrut post bases".
   3. Surface Mounted Horizontal Channels (side mounted channels)-**"**Unistrut P-1001ST Type 316 stainless steel channels and accompanying Unistrut post bases as well as wall mounted vertical channels".
   4. Brackets-**"**Unistrut" P-2515 ST of 15 inch length for Electric, and P-2542 ST of 15 inch length for Telephone and Communications. All parts given shall be Type 316 stainless steel.

c. ADD the following sentence to sub-section 3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS, Part A Exposed-Outdoor and Non-Chemical Areas Above Ground Level:

15. Equip conduits routed between structures, where structural movement is allowed, with O.Z./Gedney, or equal, 99 % aluminum expansion deflection fittings of that conduit size.

d. ADD the following paragraphs to sub-section 3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS:

E. Miscellaneous:
   2. Seal empty spare conduits (at above ground stub-ups) with an aluminum screw in plug sized to the trade size of the conduits.
      a. Threaded insert plug shall have a square head and shall be constructed from copper-free Aluminum material.
      b. Threaded insert plug shall be Type CUPX by Hubbell-Killark, Type PLG by Crouse-Hinds, or approved equal.
   3. Seal and pack/fill ends of each conduit with polyurethane foam duct sealant.
   4. In all sealing fittings, utilize sealing compound to seal around and between each conductor and associated sealing fitting body.

F. Requirements for cables inside of Manholes, Handholes, etc.:
   1. Arrange cables so that there is a minimum of crossing. Provide slack in each cable.
   2. Secure cables in handholes/manholes on support channel system as specified herein and as shown on the PLANS.

END

PART I - GENERAL

1.01 SUMMARY

A. Provide, furnish and install all electrical wire/s, conductor/s and cable/s (WCC) for all electrical, instrumentation and controls (EIC) work , as applicable and required, to make all electrical system/s complete and satisfactorily operable as specified here-in and designated per the Contract PLANS. Coordinate WCC accordingly for instrumentation and controls (I&C) requirements and applications.

B. All WCC work shall comply per the National Electrical Code (NEC), all applicable federal, state, and local codes, regulations and ordinances.

1.02 RELATED REQUIREMENTS

A. DIVISION 16 – Electrical

B. DIVISION 17 – Process Instrumentation and Controls System, PICS

C. ALL PROCESS AND/OR MECHANICAL PACKAGED SYSTEM/s --having electrical, instrumentation and control system/s, WCC, components, devices, etc. Reference all applicable and respective, related packaged system/s specification section/s, accordingly.

D. Other related work as may be designated, required, and/or called for per the CONTRACT DRAWINGS, other related TECHNICAL / EQUIPMENT SPECIFICATIONS and/ or as elsewhere defined or designated.

1.03 REFERENCES

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

1. NFPA 70: National Electric Code

2. U.L. 44: Thermoset-Insulated Wires and Cables

3. U.L. 510: Polyvinyl chloride, polyethylene, and rubber insulated tape

4. U.L. 1685: Vertical Tray Fire Propagation and Smoke-Release test for electrical and fiber optic cables

5. IECA S-95: Power Cables rated 2000V or less for distribution of electrical Energy

6. NECA WC-70: Power Cables rated 2000V or less for distribution of electrical Energy

7. ASTM B8: Standard Specification for concentric-lay, stranded copper conductors --hard, medium-hard, and soft

8. OWNER's Conductor Color Code standard –as designated here-in: Section 16200, 1.05D.

1.04 – 1.05 (NOT USED)

1.06 SUBMITTALS

A. Submittal/s per product information –catalog data sheets, product ratings, etc. per requirements and compliance per Division 1 – General Provisions, Section 01300, "Submittals".

1.07 – 1.10 (NOT USED)

1.11 OPERATION AND MAINTENANCE MANUALS

A. Operations and Maintenance (O&M) Manuals –include all approved WCC submittals in the CONTRACT O&M per Section 01730.

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. Multi-conductor I&C cable/s: Color coding is specified in the multi-conductor cable type specification--as designated per the multi-conductor cable manufacturer.

B. Power and control WCC: provide single conductor/s with integral insulation pigmentation of the designated and/or required color. Phase colors as listed below shall be provided in all instances.

C. Phase A, B, and C implies the direction of positive phase rotation for AC power voltage.

D. Implement OWNER's authorized conductor color code as designated below:

1. Electric Power WCC compliance per COA, Austin Energy Utility

System voltage/s	Conductor	Conductor Color
a. All systems	Ground	Green
b. 120/240 volts, 1-phase, 3-wire	Hot Leg, L1 Other Hot Leg, L2 Neutral, grounded	Red Black White

c. 120/208 volts, 3-phase, 4-wire	Phase A Phase B Phase C Neutral, grounded	Red Black Blue White
d. 277/480 volts 3-phase, 3-wire *	Phase A Phase B Phase C Neutral, grounded *	Brown Yellow Purple Gray *
***** 3-phase, 4-wire service drop from the power company; neutral is pulled and grounded at first main disconnect only; neutral conductor shall not be installed in electrical power distribution system **-- thereby standard practice does not utilize 277V, 1-phase power (line to neutral)**		
e. Motor space heater/s @ 120 volts, 1-phase wrapped	Hot Leg Neutral	Black Black w/white color vinyl tape
f. DC circuit installed in raceway	Positive (+) Negative (-)	Blue Brown

2. Control Panel WCC shall be rated 41 strand, tinned copper, 600V insulation --rated Type SIS --- WCC color code as follows:
   a. AC controls wire — Red
   b. Annunciator contacts — Yellow
   c. DC controls — Blue
   d. DC (+) power — Red
   e. DC (-) power — Black
   f. AC Hot — Black
   g. AC Neutral — White
   h. PLC/RTU discrete Input — Purple
   i. PLC/RTU discrete Output — Pink

E. All WCC shall be color coded and tagged per COA, FE AW standard per section 16205 “Wire and Cable Tagging”.

F. Use the manufacturer’s name, model or catalog number, if for purpose of establishing standard quality.

G. Splices are not approved –exception at lighting fixture/s and convenience receptacles.

H. Samples of all WCC shall be submitted when so requested by the ENGINEER/OWNER for the purpose of determining acceptability of the wire. WCC which have been rejected shall not be used at all. Such rejected WCC shall be removed from OWNER’s premises.

I. Multi-conductor cable is NOT APPROVED.

2.03 FUNCTIONAL REQUIREMENTS

A. Single Conductors at 600V insulation rating:

1. Unless noted elsewhere or otherwise designated, all power and control WCC shall be 98% conductivity, soft annealed, stranded copper with 600V insulation -- rated Type XHHW-2. Grounding WCC shall be bare, hard annealed, stranded copper.

2. Use only WCC meeting applicable requirement per UL 44, UL 1685 and IECA S-95-658 (NEMA WC70).

3. Power WCC shall not be smaller than #12 AWG, unless otherwise noted on the Contract PLANS.

4. Control WCC shall not be smaller than #14 AWG.

5. WCC shall be marked every two feet (2'-0") with the size, type and voltage rating as well as the Manufacturer's name and measurement markers.

6. Unless otherwise noted, conductor size/ampacity rating indicated are based on copper conductor. Do not provide conductor smaller than that designated -- comply per N.E.C.

7. Approved WCC manufacturers: Anaconda, Cyprus (Rome), Southwire, Okonite, Triangle, or approved equal.

8. Where flexible power/power and controls cords and cables are supplied, provide same per Type SEOOW rated -- flexible stranded copper conductor/s, 600V insulation rating –with quantity and size conductors as required and/or where designated per the CONTRACT PLANS.

B. Single Pair Instrumentation Cable – #16 AWG, stranded, twisted, shielded pair (2), 98% conductivity copper conductors, 600V insulation and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% pair conductors coverage -- rated Type TC Cable

1. Single pair instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Shall be rated for cable tray, conduit and/or other approved raceway. Minimum temperature rating shall be 90-degree C dry locations, 75-degree C wet locations.

C. Single Triad Instrumentation Cable – #16 AWG, stranded, twisted, shielded triad (3) copper conductors, 600V insulation, and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% triad conductors coverage -- rated Type TC Cable

1. Single triad instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Suitable for installation in cable tray/s, conduit and/or other approved raceway/s. Minimum temperature rating shall be 90-degree C dry locations, 75-degree C wet locations.

D. Equipment Grounding Wire/Conductor:

1. Provide stranded, copper conductor/s as designated, shown and required per N.E.C. for electrical system grounding and equipment grounding.

2. Provide conductor/s with green color, 600V insulation, minimum thickness of 1/32 inch -- rated Type XHHW-2.

E. All control panel wiring shall be flexible, 41 strand, tinned copper, 600V insulation, Type SIS -- not smaller than #14 AWG (unless approved by Austin Water), color coded as outlined here-in per section 16200 2.02 D.2.

F. All WCC shall be new, unused, in good condition and shall be delivered in standard coils, packages or reels. If wire used is different than what is specified, samples of wire shall be submitted for the purpose of determining acceptability of the wire. Wire which has been rejected shall not be used again. Such rejected wire shall be removed from the Owner's premises. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner or his representative.

G. Power conductors shall not be smaller than No. 12 AWG, except for control and alarm wiring where No. 14 AWG shall be used as minimum size wire when protected by a 15 amp fuse/circuit breaker.

H. The contractor may, if he deems it necessary or advisable, use larger sized conductors than those required. In no case shall there be a voltage drop greater than that allowed by the N.E.C.

2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. Do not exceed WCC manufacturer's recommendations for maximum pulling tension and minimum bending radii. Pulling compound shall be used. Use only UL listed compound compatible with WCC outer jacket and with the raceway utilized.

B. Contractor shall provide and install all low voltage (120V, 208V, 240V, 480V, etc.) WCC for power distribution equipment and associated hardware designated and required per the CONTRACT PLANS.

C. Tighten all screws and terminal bolts using torque type wrenches, and/or drives to tighten to the inch-pound requirements of the NEC and UL.

D. When single WCC in man-holes, hand-holes, vaults, cable trays and other designated location and/or raceway(s) are not wrapped together by some other means, such as arc and fireproofing tapes, bundle throughout their exposed length conductor(s) entering from each conduit/raceway with nylon, self-locking, releasable cable ties placed at interval not exceeding 12 inches on-centers.

3.02 (NOT USED)

3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS

A. Support all conductors in vertical conduits or raceways in the manner set forth in Article 300-19 of the latest revision of the National Electric Code. Do not use lighting fixtures for raceways or circuits other than parallel wiring of fixtures.

B. Do not make any splices or taps in any conductor except where absolutely required for 120 volt circuits feeding lights or receptacles. Such splicing may only take place in splice/junction boxes. Elapsed time meters are the only exception to not using a junction box.

C. Tag all power wiring in all pull boxes, wire ways, motor control center wire ways, panel board wiring gutters, light switch boxes, receptacles, disconnect switches etc. Use heat shrinkable slip-on type tags, approved for this use, as manufactured by Raychem, 3M, Panduit, or owner approved equal. See Section 16205, Wire and Cable Tagging Standard for additional requirements.

D. All interconnect wiring going from one compartment to another, or between two separate pieces of equipment must terminate at a terminal block on each end, i.e. entering and leaving a compartment or piece of equipment.

E. All wiring passing between cabinets shall be protected by a rubber grommet or approved nipple with bushings.

F. All wire terminations shall be made with a mechanical compression type lug or terminal specifically designed to accept stranded wire. Do not terminate by wrapping the wire around the screw.

G. Number 8 AWG and larger wire shall utilize a crimper with a die set to install lugs to the wire.

H. No more than two wires/ lugs per terminal will be allowed unless ring type lugs are used. A maximum of three wires will be permitted if all wires are using ring lugs.

I. All current transformer loops shall utilize ring terminals and shorting terminal boards to avoid open circuiting the secondary of a CT.

J. All wiring run to the front door panel shall have a spiral wrap and tie wrapped to protect wires from being pinched between door and panel. A loop (slack) in conductor(s) shall be provided to allow door to open freely.

K. All main panel wiring shall be run in a raceway such as Panduit. All wiring run from the Panduit to the devices shall be neatly run and tie wrapped. If Panduit is not practical, wires shall be neatly run and tie wrapped.

L. Equipment grounding wire run in conduit shall have an identifying green covering or green color coding at each end terminations and at junction box or pull box locations along its run length.

M. Where the capacity of a single feeder is great enough to require parallel conductors in more than one (1) conduit, each conduit must contain the same number and length of conductors in all phases (legs) of the feeder, including any neutral conductors per the N.E.C.

N. Under no circumstance shall circuits above 600 volts and those below 600 volts be pulled in the same conduit.

O. Separate low level circuits (such as phone line) from noisy and power circuits by a minimum distance of 1 foot.

P. Bolted and compression connections/terminations for electrical conductors shall be thoroughly cleaned, covered, and sealed with a light, pliable, waterproof film of commercial paste or sealant to prevent oxidation and/or corrosion. Apply sealant to cover complete conductor termination and cover/extend past end of conductor insulation. This is typically required for Wastewater Facilities and hazardous, damp and/or corrosive areas. Acceptable conductor/termination sealant manufacturers are Noalox or approved equal. Include sealant submittal data with WCC submittals.

Q. Where mechanical assistance is used for pulling conductors, a wire pulling compound shall be used (Polywater, or approved equal, as indicated by conductor manufacturer) having inert qualities that do not harm the wire insulation or covering and shall be free from grease, filings or foreign matter before conductors are pulled. Do not exceed cable Manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

R. Wiring shall be tagged with Raychem Wire Markers, or approved equal, at panel boards, and all termination points with numbers conforming to Section 16205. Power wiring labels shall be white with black letters.

S. Lighting and receptacle wiring may use silicone filled spring type wire connectors in approved locations. This applies to lighting and receptacle circuits only.

T. In no case shall DC voltage circuits and AC circuits be pulled in the same conduit or raceway.

3.04 – 3.07 (NOT USED)

3.08 TESTING AND INSPECTION

A. Field test, check and inspect all installed WCC --- comply per requirements per Section 16951 “Calibration and Testing”.

3.09 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

A. No separate payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SPECIAL PROVISION To

Standard Specification Item No. 16200 (Version 9/30/2015)
Wires, Conductors and Cable – 600V and Below

For this project Item No. 16200 Wires, Conductors and Cable – 600V and Below of the Austin Water Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this Section of the Austin Water Standard Specifications are waived or changed.

1. DELETE "the Owner or his representative." from the last sentence of sub-section 2.03 FUNCTIONAL REQUIREMENTS, paragraph F, and ADD "the Owner or the Owner's representative."

2. ADD the following sub-sections to PART II – PRODUCTS:

2.04 MULTI-CONDUCTOR POWER WIRING

A. General: Multi-Conductor power system cables shall be shielded and shall be rated 600 volts. Cables shall be suitable and rated for installation for AC or DC service in wet or dry locations at conductor temperatures of 90 degrees C. Cable shall be suitable and rated for installation in conduit system, cable tray system, and directly buried in the ground/earth where electrostatic shielding is required.

B. Features: As minimum, the Multi-Conductor shielded power cables shall have the following features:
   1. Passes the IEEE 383 and IEEE 1202 flame tests as well as ICEA T-29-520 (210,000 BTU/hour) flame test.
   2. Conductors: Each individual conductor in each multi-conductor cable shall be copper per ASTM B-3. Each conductor shall have the following additional features:
      a. Stranding: Class B stranding per ASTM B-496
      b. Insulation: Meet or exceed the requirements of UL 1581 and ICEA S-73-532
         1) Individual conductor insulation shall be type XHH/XHHW-2
      c. Conductor Identification: Color coded using base colors according to the following:
         1) Power Conductor No. 1: Black
         2) Power Conductor No. 2: Red
         3) Power Conductor No. 3: Blue
         4) Power Conductor No. 4: Orange
         5) Equipment Grounding Conductor, when applicable: Green
         6) Grounded Conductor, when applicable: White
   3. Size of each conductor and quantity of conductors: Sizes and quantities shall be as shown on the Conduit/Wire Schedule shown on the Drawings.
   4. Overall Cable Binder Tape: 100 percent binder tape, longitudinally applied.

5. Overall Outer Jacket: Each multi-conductor cable shall be covered with overall black ethylene-propylene heat, moisture, flame and chemical resistant outer jacket. Minimum jacket thickness is 60 mils.
6. Manufacturer: Okonite-FMR Okoseal, Type TC-ER, or approved equal.

2.05 MULTI-CONDUCTOR CONTROL WIRING

A. General: Multi-Conductor control system cables shall be shielded and shall be rated 600 volts. Cables shall be suitable and rated for installation for AC or DC service in wet or dry locations at conductor temperatures of 90 degrees C. Cable shall be suitable and rated for installation in conduit system, cable tray system, and directly buried in the ground/earth where electrostatic shielding is required.

B. Features: As minimum, the Multi-Conductor shielded control cables shall have the following features:
   1. Passes the IEEE 383 and IEEE 1202 flame tests as well as ICEA T-29-520 (210,000 BTU/hour) flame test
   2. Conductors: Each individual conductor in each multi-conductor cable shall be copper per ASTM B-3. Each conductor shall have the following additional features:
      a. Stranding: Class B stranding per ASTM B-8
      b. Insulation: Meet or exceed the requirements of ICEA S-73-532
      c. Conductor Identification: Color coded using base colors and tracers according to the following:

Conductor Size	Number of Conductors in a cable	Conductor Insulation Thickness	Cable Maximum Overall Diameter	Color Code		
				Cond. No.	Base Color	Tracer
#12 AWG	Seven (7)	30 mils	0.74 inches	1	Black	----
				2	White	----
				3	Red	----
				4	Green	----
				5	Orange	----
				6	Blue	----
				7	White	Black
#12 AWG	Twelve (12)	30 mils	0.96 inches	1	Black	----
				2	White	----
				3	Red	----
				4	Green	----
				5	Orange	----
				6	Blue	----
				7	White	Black
				8	Red	Black
				9	Green	Black
				10	Orange	Black
				11	Blue	Black
				12	Black	White
				1	Black	----

Conductor Size	Number of Conductors in a cable	Conductor Insulation Thickness	Cable Maximum Overall Diameter	Color Code		
				Cond. No.	Base Color	Tracer
#12 AWG	Nineteen (19)	30 mils	1.09 inches	2	White	----
				3	Red	----
				4	Green	----
				5	Orange	----
				6	Blue	----
				7	White	Black
				8	Red	Black
				9	Green	Black
				10	Orange	Black
				11	Blue	Black
				12	Black	White
				13	Red	White
				14	Green	White
				15	Blue	White
				16	Black	Red
				17	White	Red
				18	Orange	Red
				19	Blue	Red

3. Size of each conductor and quantity of conductors: There shall be three (3) kinds of multi-conductor control cables: Seven (7) conductor (#12 AWG) cables, Twelve (12) conductor (#12 AWG) cables, and Nineteen (19) conductor (#12 AWG) cables. Sizes and Quantities shall be as shown on the Conduit/Wire Schedule shown on the Drawings.
4. Overall Cable Shield: 100 percent shield consisting of 5-mil corrugated copper tape, longitudinally applied.
5. Overall outer jacket: Each multi-conductor cable shall be covered with overall black thermoset chlorinated polyethylene flame retardant outer jacket. Minimum jacket thickness is 60 mils.
6. Number of conductors in a cable: Number of conductors shall be as shown on the Conduit/Wire Schedule shown on the Drawings.
7. Manufacturer: Okonite FMR-LCS-Okolon TS-CPE, or approved equal.

3. ADD the following items to sub-section 3.03 ERECTION, INSTALLATION, AND APPLICATION INSTRUCTIONS:

U. For power wiring terminations for motors rated 600V and below, utilize Multi-Cable Connector Blocks. The Multi-Cable Connector Blocks shall be U. L. 486A listed, rated for 600V, pre-filled with an oxide inhibitor and insulated with UV rated chemical resistant plastisol compound that will not support combustion. They shall be suitable for use with Aluminum and Copper conductors. The Multi-Cable Connector Blocks shall be as manufactured by Polaris Connectors Series Polaris Grey, or approved equal.

V. Where indicated on the PLANS for submersible applications of 600V and below power and control wiring terminations, utilize Submersible Splice Connectors. The

Submersible Splice Connectors shall be U. L. 486D listed, rated for 600V, manufactured from high strength 6061-T6 aluminum alloy and encapsulated in rubber with a nominal thickness of 125 mils and high dielectric strength. They shall be suitable for use Aluminum and Copper conductors. The Submersible Splice Connectors shall be as manufactured by Polaris Connectors Series ISPBS Submersible Splice Connectors and Series ISPB2/0 and ISPBO2/0 Submersible Streetlight Connectors, or approved equal.

END

PART I - GENERAL

1.01 SUMMARY

A. This specification section establishes the wire, conductor and cable tagging method to use for all electrical, control and instrumentation systems for the Austin Water.

1.02 RELATED REQUIREMENTS

A. Work as called for on PLANS, or in this or other Specification Sections.

1.03 – 1.11 (NOT USED)

PART II - PRODUCTS

2.01 (NOT USED)

2.02 MATERIALS/CONSTRUCTION

A. Wire, Conductor and Cable Tagging

1. In general, all wiring shall be tagged at all termination points and at all major access points in the electrical raceways. A termination point is defined as any point or junction where a wire or cable is physically connected. This includes terminal blocks and device terminals. A major access point to a raceway is defined as any enclosure, box or space designed for wire pulling or inspection and includes pull boxes, manholes, and junction boxes.

2. Wire tags shall show both origination and destination information to allow for a wire to be traced from point-to-point in the field. Information regarding its destination shall be shown in parenthesis.

B. Single Conductor, Wire and Cable Tagging

1. The following is the format to use for single conductor, wire and/or cable tags. Tag information to the left refers to the origination point. Tag information in parenthesis refers to point of destination.

   XXXX XX (XXXX-XXXX-XXXXX / XXXX XX)

   Device Terminal Identifier No. (Equipment Tag No.*/Device Terminal Identifier No.)

   *For wiring within a piece of equipment, control panel, junction box, etc., the Equipment Tag No. is not required, only the Device Identifier and Terminal Number from the point of origination.

Example: For a wire connected from Terminal block 1 terminal 23 to relay CR1 terminal 9, the correct tag would be TB1-23(CR1-9) at the terminal block and CR1-9(TB1-23) at the relay.

C. Device Identifier

1. The Device Identifier uniquely identifies a device within a piece of equipment. Examples are: TB1, for terminal block number 1 and CR02, for control relay # 02. For existing equipment, refer to existing device tags or labels and/or equipment documentation. For missing tags or new equipment, consult with OWNER.

D. Terminal Number

1. The Terminal Number along with the Device Identifier, identify which specific point in the equipment the wire must be terminated to. Refer to manufacturer's labeling or record drawings for device terminal numbers.

E. Equipment Tag No.

1. The Equipment Tag Number is the physical tag attached to the equipment. For existing equipment, please refer to the Facility in question. For new or missing equipment tags please refer to the Contract PLANS Mechanical Systems for equipment tag identification and/or designation.

F. TAG SPECIFICATIONS

1. Wire tags shall be yellow for control wiring and white for all AC/DC power wiring. Tags shall be heat shrink type as manufactured by Raychem, 3M, Panduit, or OWNER approved equal with the tag numbers typed with an indelible marking process. Character size shall be a minimum of 1/8" in height. Hand written tags are not allowed. Tags shall be heat shrunk once proper installation and operation is completed and verified.

2.03 – 2.04 (NOT USED)

PART III - EXECUTION

3.01 GENERAL

A. PULL BOXES, MANHOLES, AND JUNCTION BOXES

1. For all groups of conductors, tags shall be yellow Phenolic with black lettering, attached with black tie wraps. Submit tag sizing and nomenclature to OWNER for approval.

B. DEVIATIONS

1. For deviations from this wire tagging specification, or for cases not covered by these specifications, submit the proposed tagging system to Austin Water for approval prior to use.

C. GRAPHIC DISPLAY

1. Comply per the following graphic display/outline for the specified conductor/wire/cable tagging method.

2. Single conductor wire tagging within same enclosure and/or equipment.

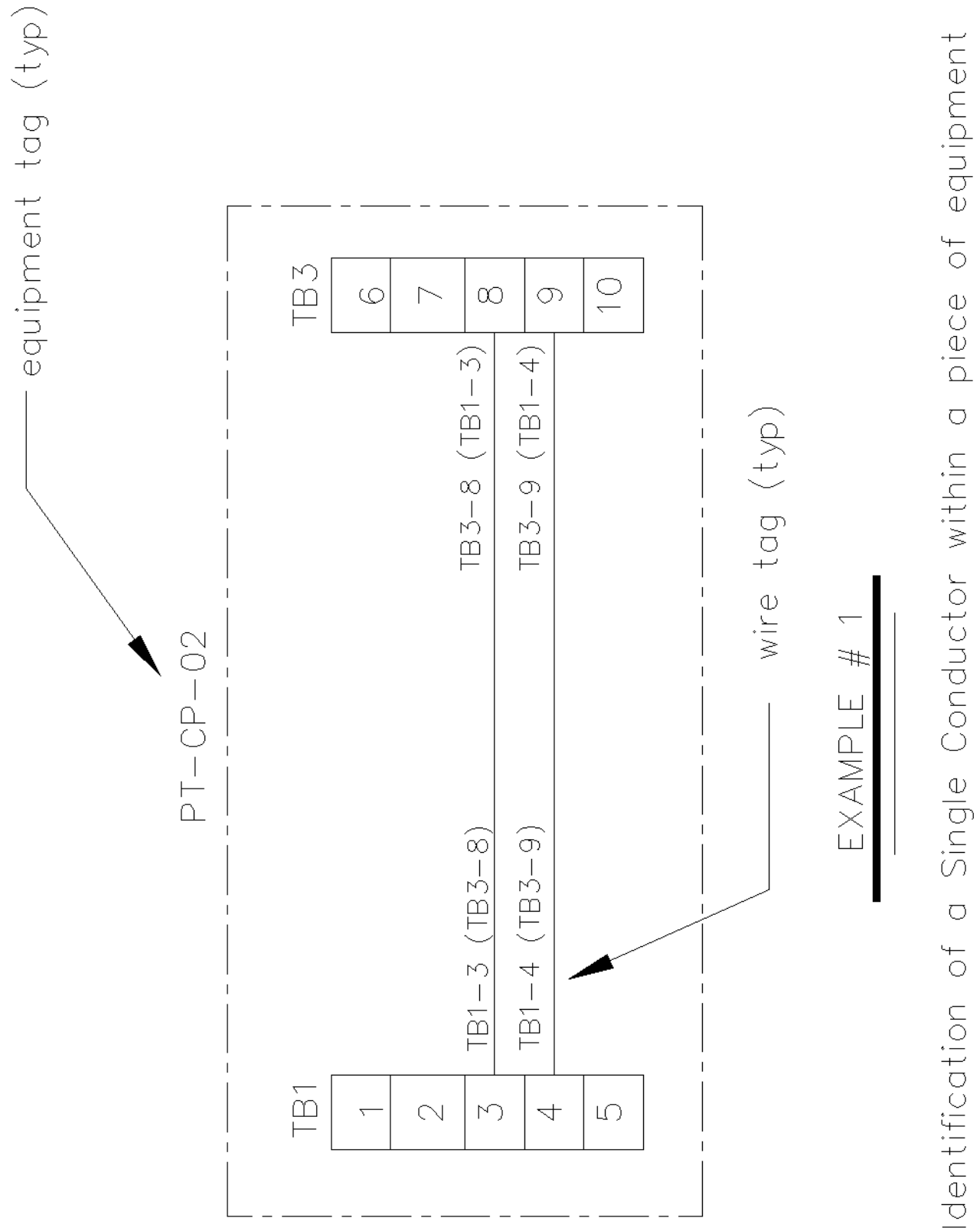
3. Single conductor wire tagging between two separate enclosures and/or equipment.

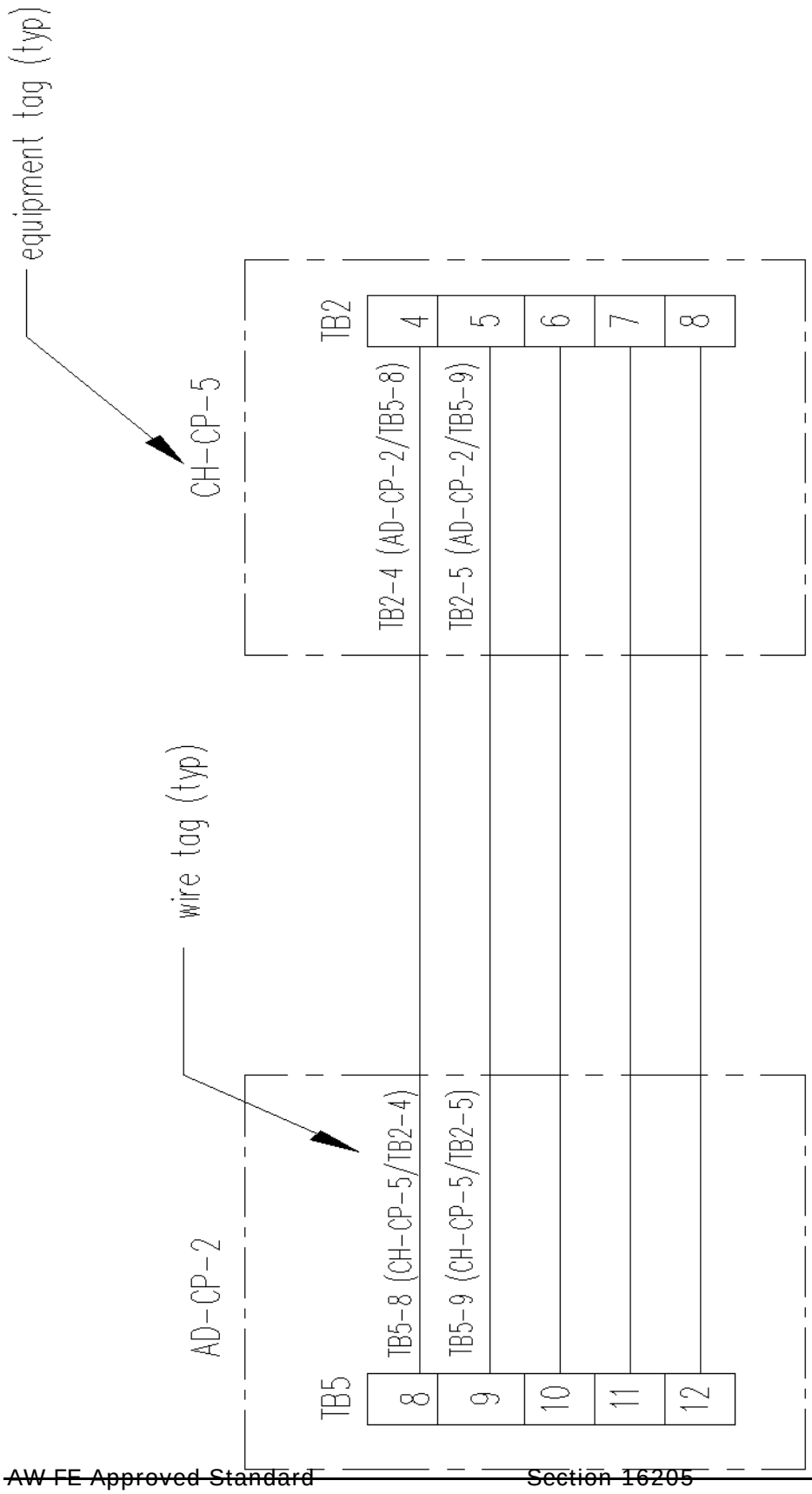
3.02 – 3.11 (NOT USED)

3.12 MEASUREMENT AND PAYMENT

A. No separate payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION


equipment tag (typ)
PT-CP-02
TB3
6
7
8
9
10
TB3-8 (TB1-3)
TB3-9 (TB1-4)
TB1-3 (TB3-8)
TB1-4 (TB3-9)
TB1
1
2
3
4
5
wire tag (typ)
EXAMPLE # 1
Identification of a Single Conductor within a piece of equipment



EXAMPLE # 2

Identification of a Single Conductor that interconnects two pieces of equipment

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SECTION 16222

ELECTRIC MOTORS, INDUCTION, 600 VOLTS AND BELOW

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install mill and chemical duty high efficiency, squirrel cage induction motor as hereinafter specified. Furnish and install as integral part of rotating driven equipment unit.

1.02 RELATED REQUIREMENTS

A. Driven equipment specifications, PLANS, and equipment manufacturer requirements define voltage, speed, special features, driven equipment requirements, and special submittal data.

B. Related work as called for on PLANS or specified in this or other Sections of the Specifications.

1.03 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
   1. American Bearing Manufacturers Association (ABMA)
      a. ABMA 9 Load Ratings and Fatigue Lift for Ball Bearings.
   2. Institute of Electrical and Electronic Engineers (IEEE)
      a. IEEE 112 Standard Test Procedures for Polyphase Induction Motors and Generators
      b. IEEE 841 Standard for Petroleum and Chemical Industry-Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors-Up to and Including 500 Hp
   3. National Electrical Manufacturers Association (NEMA)
      a. NEMA MG 1 Motors and Generators.

1.04 SUBMITTALS

A. Furnish the following in accordance with Specifications Section 01300, “Submittal Procedures” and Section 01730, “Operation and Maintenance Data”
   1. Shop drawings. In addition to the items specified in Section 01300, “Submittals”, furnish the following information with the driven equipment submittal:
      a. Full nameplate information in accordance with NEMA Standard MG 1-10.37; full load and locked rotor torque, efficiency and power factor data at full load, 3/4 load, and 1/2 load, space heater wattage and voltage, safe stall time, inertia, number of allowable starts (cold/hot) per day and associated time between successive starts.

b. When power factor correction capacitor is provided in motor circuit, all nameplate information affected by addition of capacitor to be corrected and submitted in addition to information described herein.
c. Thermal damage curves and speed-torque characteristic
d. Full load, no load, and locked rotor ampere at rated voltage
e. Wiring diagrams
f. Dimensioned drawings, weights, bearing calculations and data.

2. Operation and Maintenance Manuals: Furnish as part of driven equipment O&M manual.

1.05 QUALITY ASSURANCE

A. Design and construction of motors to be in accordance with NEMA Standard MG 1 and applicable provisions of IEEE, ANSI, NEC, OSHA, and UL.

B. Furnish identical motors and accessories from a single motor manufacturer for multiple units of the same equipment.

C. Sole Source Responsibility: Utilize a single supplier to provide the drive motor, the driven equipment and any accessories.

1.06 DELIVERY, STORAGE AND HANDLING

A. Protect from weather and insects with polyethylene wrapper, energize space heaters to preclude moisture.

PART 2 PRODUCTS

2.01 MANUFACTURER(S)

A. Teco-Westinghouse

B. U.S. Motor

C. Reliance/Baldor

D. General Electric

2.02 MATERIALS AND/OR EQUIPMENT

A. General: Unless otherwise noted in the driven equipment specification sections, the following items apply as a default standard:
1. Enclosure: TEFC
2. Service Factor: 1.15
3. Mounting: As required by the driven equipment
4. Duty Rating: Continuous
5. 120-volt space heaters. Wire to the motor terminal box unless specified otherwise.
6. Starting: Across the line, full voltage starting
7. Frequency: 60 Hz
8. Lifting Lug

B. Performance: Unless otherwise noted in the driven equipment specification sections, the following items apply as a default standard:
   1. Brake Horsepower: As designated in driven equipment specification. Brake horsepower of the driven equipment is not to exceed motor nameplate horsepower rating, excluding any service factor.
   2. Power Factor:
      a. Minimum full load power factor (uncorrected) shall be 85%
      b. When shown on the PLANS, corrected minimum full load power factor shall be 95%
   3. Efficiency: Motors shall be of a premium energy-efficient design per NEMA MG 1, Tables 12-12 and 12-13.
   4. Locked Rotor kVA Code G or lower for motors sized 15 horsepower and larger.

C. Construction and Materials:
   1. Frame: Cast iron, size per NEMA designations
   2. End Shields: Cast iron
   3. Drain/Breather: Stainless Steel "T" drains in end brackets
   4. Fan Shroud: Cast iron
   5. Motor Terminal Box: Oversized, cast iron, diagonally split, rotatable, threaded hubs for conduit attachment. Sized per NEMA MG 1, section 1, paragraph 4.19. Terminal box shall be gasketed to frame and furnished with grounding lug.
   6. Cooling Fan: Aluminum or polypropylene
   7. Wiring and Insulation: Copper with non-hygroscopic Class F insulation, Class B temperature rise not to exceed insulation temperature rating when operating at service factor rating in 40 degrees Celsius ambient according to NEMA MG 1-12.42. Include extra dips and bakes for high humidity.
   8. Rotor: Precision cast aluminum rotor conductor bars, statically and dynamically balanced.
   9. Bearings: Ball bearings, B_{10} life of 75,000-hours per ABMA 9, grease lubricated with cast iron bearing caps. Labyrinth sealed with removable grease relief plugs. Extended lubrication lines with Alemite fittings in both end shields. Provide for adding new and draining old grease without major motor disassembly. Provide grease catch pan and chute below each bearing to capture excess grease.
   10. Hardware: Stainless Steel
   11. Shaft: High strength carbon steel, precision turned and ground. Non-metallic V-ring shaft slinger to prevent moisture seepage along shaft into motor.
   12. Provide internal temperature switch with contacts rated for 120 VAC, 5 amps, when shown on the PLANS. Switch settings to be at appropriate protection temperature.
   13. Nameplate: Stainless Steel securely attached to motor with stainless steel screws. All data to be permanently stamped into nameplate. Data shall include:
      a. Horsepower
      b. RPM
      c. NEMA design
      d. Phase
      e. Hertz
      f. Service factor

g. NEMA nominal efficiency
h. Power factor
i. Frame size
j. Duty
k. Class of insulation
l. Ambient temperature
m. Locked rotor KVA code
n. Full load amps
o. Locked rotor amps
p. Bearing identification by ABMA number
q. Model and catalog number
r. When power factor correction is provided in motor circuit, an auxiliary stainless steel nameplate to be securely attached to respective motor with stainless steel screws. Auxiliary nameplate to read "___ FLA with ___ KVAR power factor correction capacitor installed", with applicable values inserted as required. Sentence to be permanently stamped into auxiliary nameplate.

2.03 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Perform routine (production) tests on all motors in accordance with NEMA MG 1 and IEEE 112.
2. For motors 100 Hp and smaller, testing can be conducted on an identical motor.
3. Testing:
a. No load power at rated voltage
b. Locked rotor current
c. Efficiency at 50, 75 and 100 percent of rated horsepower in accordance with IEEE 112, Test Method B, and NEMA MG 1, paragraphs 12.59 and 12.60.
d. Power factor
e. Speed
f. Current at rated horsepower
g. kW input at rated horsepower

B. Test Report Forms:
1. Routine Tests: IEEE 112, Form A-1
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-11.

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Follow manufacturer's published instructions and alignment requirements for driven unit. Measure and record amperes at maximum load and verify proper overload heater selection.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 16264

208/120 VOLT UNINTERRUPTIBLE POWER SUPPLY

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install the 208/120 Volt Uninterruptible Power Supply (UPS) system as specified herein and as shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The PLANS designate the size, rating, and other requirements of the UPS.

B. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Specifications. Submittals shall include:
   1. Dimensioned/scaled top and bottom views, front elevations, and internal component/device layouts
   2. One-line and wiring diagrams,
   3. Catalog cut sheets, including weight and heat dissipation

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. O&M Manuals shall include copies of the approved shop drawings. Also, as minimum the Operations and Maintenance Manuals shall include:
   1. Copies of certified and approved shop drawings.
   2. Detailed information on each component used, including:
      a. Installation and operation manual.
      b. Renewal parts bulletin.
      c. As built drawings, including approved shop drawings.
      d. Test data.
      e. Detailed UPS setting parameters, DIP-switch settings, ranges, options, operating setting and calibrating instructions, etc.

1.04 QUALITY ASSURANCE

A. The UPS shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, U.L., and NEC standards.

B. The UPS shall be as manufactured by “Liebert Model eXM” meeting these specifications and all the additional options required hereinafter, or approved equal.

1.05 DELIVERY, STORAGE AND HANDLING

A. Protection
   1. The Contractor, and hence the UPS supplier, shall be responsible for safety of the UPS during storage, transporting and handling.
   2. At all times the UPS shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   3. Interior and exterior of the UPS shall be kept clean at all times.
   4. Size, furnish and install temporary space heaters within the UPS and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:
   1. Environmentally protected and stored in climate controlled (temperature and humidity) environment at the job site. Size, furnish and install temporary air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
      a. Ambient Dry Bulb Temperature:
         1) Minimum: 68 degrees Fahrenheit.
         2) Maximum: 85 degrees Fahrenheit.
      b. Ambient Relative Humidity: Maximum: 50%.
   2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
   3. Upon arrival of equipment onto job site, a maximum of one day shall be allowed for equipment to be left without to allow proper transition of power of equipment, especially any 120 VAC powered equipment, to ensure all air conditioning and heating equipment are fully operational with a maximum of a 10 minute down time during this transition of power.
   4. Furnish and install replacement air filters, etc., as required for proper operation of the environmental control equipment.

1.06 SPECIAL MANUFACTURER'S SERVICES

A. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to perform the field testing hereinafter specified. Include checking alignment of parts, wiring connections, operation of all parts (inverter, battery charger, rectifier, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the OWNER with a report certifying that the equipment was installed, adjusted, properly tested, and set in accordance with the manufacturer's recommendations and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications.

B. Prepare an arc-flash study, harmonic study, motor starting study and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services".

C. Manufacturer's technical representative is to set, adjust and test all circuit breakers, relays, motor circuit protectors, etc. in the presence of a representative of the OWNER. The settings will be based on coordination and short circuit studies performed per subsection 1.06.B, this Section of the Specifications. Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 and 01730 of the Contract Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.

D. Any problems encountered with the operation of equipment, parts, components, etc. installed within the UPS system shall be repaired/remedied by the manufacturer's technical representative.

1.07 SPARE PARTS

A. One (1) quart of touch up paint.

PART 2 PRODUCT

2.01 UNINTERRUPTIBLE POWER SUPPLY SYSTEM REQUIREMENTS AND UNIT DESCRIPTION

A. General System Requirements:
   1. Uninterruptible Power Supply system shall consist of the following major sub-components as a minimum:
      a. Solid State Inverter, Pulse width modulated design
      b. Solid State Rectifier
      c. UPS system controller with manufacturer’s standard field adjustable control and protective features
      d. UPS Module Internal Bypass Static Switch
      e. External Maintenance Bypass Switch
      f. Input and output circuit breakers
      g. Batteries
      h. Battery Charger
      i. Input filters and surge protection
      j. Mounting enclosures and miscellaneous accessories
   2. The UPS manufacturer shall furnish and install the UPS system complete with all sub-components required to achieve a functional uninterruptible power system in compliance with the requirements of the PLANS and Specifications at no additional cost to the Owner regardless if all of the needed UPS sub-components are identified in the above listing.
   3. Enclosure:
      a. Provide the number of modular free standing enclosures as hereinafter specified and as shown on the PLANS and as required to house the various UPS system subcomponents. Mount and wire all components inside of each enclosure unless shown/specified otherwise.
      b. Enclosure shall be the totally enclosed, NEMA Type 1 rated, and suitable for back-to-wall mounting. Refer to the PLANS for additional dimensional

requirements. Each enclosure shall have a hinged door with latching mechanism and exterior operating handle. Three point type latch is preferred. Each enclosure shall have provisions for lifting and jacking. Each enclosure shall have field adjustable leveling feet as well as suitably sized casters.

c. Enclosure finish shall be primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be manufacturer's standard.
d. Provide enclosure grounding lug and door bonding jumper for each enclosure section, sized per NEC.

4. The UPS shall consist of a configurable bypass mode for automatic or manual bypass to the AC input source.
5. For additional construction notes, features, and special requirements, refer to the PLANS and the Specifications.
6. UPS complete with all accessories shall not exceed the dimensions shown on the PLANS. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below, as shown on the PLANS.

B. General Requirements:
1. Duty: Continuous
2. Number of Phases: Three
3. Apparent Power: As shown on the PLANS
4. Run Time (without input power): Minimum duration of thirty (30) minutes in the event of permanent power loss to the UPS AC input with the UPS serving all loads operating at full load.
5. Power Factor: Greater than 0.9 lagging
6. Operating Temperature Range: 0 - 40°C, with relative humidity of 20 – 90% non-condensing.
7. Connections: Provide termination lugs to facilitate the termination of the field shown on the PLANS.
8. UPS System Input:
   a. Input Voltage: 208/120 volts AC, 60 Hz, three phase, four wire.
   b. Voltage Range: +10%, -20% of Nominal
   c. Frequency Range: 45 to 65 Hertz.
   d. Power Factor: Minimum 0.80 lagging
   e. Inrush Current into overall system: no greater than 800% of full load current
   f. Current Limit: 115% of nominal AC input current, at minimum.
   g. Input Current Walk-In Duration: 5 to 20 seconds, field adjustable.
   h. Current Distortion: 5% reflected input THD maximum at full load.
   i. Surge Protection: The UPS shall be able to sustain input surges without damage per criteria listed in ANSI C62.41 Category A and B or IEC 1000-4-5.
   j. Connections: Provide termination lugs as required by the PLANS
9. UPS System Output:
   a. Wave form: Continuous, 208/120volts AC, 60Hz, three phase, four wire, sine wave.
   b. Voltage Regulation: ±3%
   c. Frequency: Nominal frequency ±0.1%
   d. Frequency Slew Rate: 5.0 Hertz per second maximum. Field selectable from 1 to 5 Hertz per second.

e. Phase Displacement: ±2 degree for balanced load, ±4 degree for 100% unbalanced load.
f. Bypass Line Sync Range: ±2 Hertz. Field selectable.
g. Voltage Distortion: 5% THD for 100% nonlinear loads, maximum
h. Load Power Factor Range: 1.0 to 0.7 lagging
i. Output Power Rating: Rated kVA at 0.8 lagging power factor
j. Overload Capability:
   1) 125 % for 90 seconds (without bypass source)
   2) 150 % for 30 seconds (without bypass source).
k. Inverter Output Voltage Adjustment: ±5 %
l. Voltage Unbalance: ±2 % for 100 % unbalanced load
m. Filtering: Filtered with 0.3% IEEE surge let-through and zero clamping response time, complying with UL 1449 requirements.

C. UPS Controller Features:
1. Manufacturer's standard microprocessor based automatic controller for controlling and monitoring the UPS start-up, shutdown, load transfer, bypass, battery charging/testing, alarming, and protective functionality.
2. Combination keypad and graphical LCD display user interface means for status display and monitoring. The display shall be used to show a mimic single-line diagram of the UPS with power flow, UPS metering data, status, and alarms per the manufacturer's standard. Furnish and install additional pushbuttons, selector switches, indicating pilot lights, etc., as needed for the proper monitoring and control of the UPS system per the manufacturer's standard product offering. All of the operator controls and monitors shall be located on the face of the UPS enclosure door. Additional features of the monitoring system shall include:
   a. Menu-driven display with pushbutton navigation
   b. Real time clock (time and date)
   c. Alarm history with time and date stamp
   d. Battery backed-up memory
   e. Metering and display of input, battery, and output voltages and currents
   f. Provisions for field adjustment of the UPS setpoints.
3. The UPS controller shall consist of automatic self test, executed on start up and at regular field adjustable intervals, fault detection annunciating self test failure functionality.
4. The UPS shall consist of automatic voltage regulation to maintain its sine wave output in accordance to these specifications. The settings for the UPS AC input source voltage high and low values to initiate transfer to battery power shall be field adjustable.
5. Indications and alphanumeric display, at minimum:
   a. UPS On Status
   b. Fault
   c. On Battery
   d. Bypass
   e. Battery Replacement Needed
6. Audible Alarms , at minimum:
   a. UPS Failure
   b. Battery Failure
   c. Power Loss to the UPS
7. Push Buttons, at minimum:

a. Energizing UPS
b. De-energizing UPS
c. Manual UPS Self test initiation
d. Alarm reset,

8. Network Interface Card:
   a. The UPS shall come equipped with an internal Simple Network Management Protocol (SNMP) adapter, which will connect the UPS directly to any I.P. based network using Ethernet communications. The UPS will become a managed device on the network. From a network management station the system administrator shall be capable of monitoring important system measurements, alarm status and alarm history data. In the event of a utility failure the SNMP shall continue with live communication without the requirement of additional or separate UPS equipment until such time as the UPS shuts down for Low battery. On resumption of Utility power the SNMP shall resume full SNMP communication automatically.

D. UPS Module Internal Maintenance Bypass Static Switch:
   1. Located integral to the UPS module
   2. Solid state type switch rated to continuously conduct the full load UPS load current, at minimum.
   3. Switch shall provide for automatic transfer of the load to an alternate bypass source, bypassing the UPS Module.

E. External Maintenance Bypass Switch:
   1. Provide make-before-break switching means for load transfers to and from the external maintenance bypass line. Switching means to enable the UPS module to be completely isolated from the electrical system and directly connect the critical load to the input power source transformer secondary, bypassing the UPS module internal static bypass transfer switch. With the critical load powered from the maintenance bypass circuit, it shall be possible to perform maintenance on the rectifier/charger, inverter, battery, and static bypass transfer switch. All energized terminals shall be shielded to ensure that maintenance personnel do not inadvertently come in contact with energized parts or terminals.
   2. External maintenance bypass switching means to be provided in a dedicated enclosure and be manually operated. The maintenance bypass switch shall be sized such to carry the full load current of the UPS inclusive of inrush current, at minimum. Also refer to the requirements of the PLANS. The maintenance bypass switch shall be installed in such a manner that the selector switch is accessible from the front of the cabinet
   3. External maintenance bypass switch shall be provided with input and output circuit breakers and shall be the standard product of the UPS manufacturer.
   4. External maintenance bypass switch is required regardless if the UPS module is provided with an internal maintenance bypass switch

F. Batteries:
   1. Type: sealed valve regulated lead acid (VRLA). The batteries shall be suitable for use in the application environment.
   2. Operating Temperature: 20 - 30°C, with relative humidity of 20 – 90% (without condensation)

3. Group mount batteries in modular cabinet(s) in a manner that facilitates maintenance and replacement in the field without disassembly of the battery cabinet.
4. Provide the required number of modular battery cabinets to obtain the previously specified minimum runtime duration at full load.

G. Battery Charger:
1. Furnish and install battery charger for charging the UPS batteries. The charger may be an integral part of the rectifier at the discretion of the UPS manufacturer.
2. Battery charger shall be sized such to recharge the batteries from a fully discharged state to 95 percent capacity within a maximum of five (5) hours.
3. Battery charger shall have means for float charging to maintain the batteries at full charge.

H. Circuit Breakers:
1. Provide thermal magnetic molded case circuit breakers with the following minimum requirements:
   a. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the bus serving the equipment. Provide the rating required to comply with Subsection 1.09, this Section of the Specifications.
   b. Current carrying capacity as determined by the UPS manufacturer for the application.
   c. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.
   d. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
   e. Provide mechanical padlock attachment for each circuit breaker.
   f. Furnish lugs for feeders where required to facilitate field wiring termination, sizes shall be as required by the PLANS.

I. Warranty: Two (2) year manufacturer's warranty

J. Accessories:
1. Auxiliary forced air cooling fans per the manufacturer's standard product offering where needed for air circulation. Thermal design shall include consideration of the installation environment. Fans control power shall be served by UPS output.
2. Provide a detailed instruction plate for convenient operation.
3. Auxiliary Contacts:
   a. Furnish and install field programmable contacts rated for 1 ampere at 24VDC, at minimum. Wire to terminal blocks. Furnish and install the quantity and state of contacts as shown on the PLANS. Contacts rated 5 ampere at 120 volts A.C. are preferred if available from the manufacturer.
4. Nameplates:
   a. Provide nameplates/legend plates for each pilot device and each component/device/equipment installed on the face and inside the enclosure of the UPS

b. Identification Nameplates, unless otherwise specified, shall be constructed of laminated 3-ply “Black-White-Black”, phenolic identification nameplates with engraved lettering. Nameplate shall be legible at a distance of six feet from the nameplate. Nameplates located on the face of the cabinet shall be secured with two Stainless Steel screws. Exception: Nameplates located inside of the UPS enclosures shall be manufacturer’s standard.

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TESTS

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Mount the UPS as shown on the PLANS. Also refer to the details shown on the PLANS.

B. Size, furnish, and install (field route) the interconnect wiring between the individual modular sections of the UPS per the NEC and the recommendations and wiring diagrams of the UPS manufacturer. Route the interconnect wiring in liquid-tight flexible conduit per Section 16150 “Raceways, Fittings, and Supports” of the Specifications. Include additional length of conduit/wire to facilitate the movement of the UPS modular sections by the Owner’s maintenance personnel for UPS maintenance and inspection. Coordinate the required interconnect conduit/wire length with the Owner and furnish and install the length required at no additional cost to the Owner.

3.03 FIELD TEST AND CHECKS

A. The following minimum test and checks shall be made before energizing the UPS. These tests shall be performed by a Factory Trained Field Technician (non sales type):
   1. Thoroughly inspect UPS.
   2. Test for proper wiring connections and operation.
   3. Calibrate, set and test UPS setpoints and protective features according to settings provided and required by this Specifications Section and as recommended by the manufacturer.
   4. Submit documentation of all tests outlined above. Include all test documentation data in operation and maintenance manuals.

3.04 EQUIPMENT PROTECTION AND RESTORATION (BY CONTRACTOR)

A. Clean and vacuum clean all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

3.05 TRAINING

A. Provide training sessions for owner's representatives for Two (2) normal workday and Four (4) working hours each day, at the job-site location. If training is conducted in less than the time required by these Specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the UPS manufacturer's non-sales-type technical representative.

C. At minimum, the training session shall include:
   1. Operation and maintenance procedure for the equipment and all components installed within the UPS.
   2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

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SECTION 16300

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install all necessary wiring devices at the locations indicated on the PLANS and as specified herein.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Contract Specifications. Include manufacturer's catalog data/notification certifying Aluminum Device Boxes, as specified hereinafter, to be 99.0% copper-free.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. O&M Manuals shall include copies of the approved shop drawings, factory and on-site/field test data.

PART 2 PRODUCTS

2.01 LIGHT SWITCHES

A. Installed indoors inside the environmentally and climate controlled ELECTRICAL ROOMS:
   1. Specification grade, 20 amp, 120/277 volts
   2. Provide the number of poles as required by the PLANS.
   3. Provide maintained action type operation, unless momentary action is specifically required by the PLANS.
   4. Ivory color switch handle operator.
   5. Manufacturer: Pass and Seymour No. PS20AC, or approved equal.

B. Installed indoors inside STORAGE ROOMS and PROCESS MECHANICAL EQUIPMENT ROOMS and installed in ALL OUTDOOR AREAS:
   1. Specification grade, 20 amp, 120/277 volts
   2. Provide the number of poles as required by the PLANS.
   3. Provide maintained action type operation, unless momentary action is specifically required by the PLANS.
   4. Factory-sealed where each switch is enclosed in a unique sealing well with double flanges that mate with the light switch cover and box assembly.
   5. Raintight, corrosion resistant and rated for use in wet locations and in Class I Division 2 hazardous areas (as classified by NEC).
   6. Manufacturer: Cooper Crouse-Hinds, Killark, or approved equal.

C. Box: Provide as hereinafter specified.

2.02 120 VOLTS AC, COVENIENCE RECEPTACLES

A. Installed indoors inside the environmentally and climate controlled ELECTRICAL ROOMS:
   1. Receptacle
      a. Specification grade
      b. Duplex, 3-wire, polarized grounding type, rated 20 amp, 125 volt, 60 Hertz
      c. Ivory color
      d. Manufacturer: Hubbell No. HBL5362I, Bryant, Pass and Seymour, or approved equal.
   2. Ground Fault Interrupter Receptacle:
      a. Provide where G.F.I receptacles are indicated on the PLANS
      b. Specification grade, weather-resistant type,
      c. Duplex, 3-wire, polarized grounding type, rated 20 amp, 125 volt, 60 Hertz.
      d. Red indicator light
      e. Test and Reset pushbutton
      f. Ivory color.
      g. Manufacturer: Pass & Seymour Cat. No. 2095TRWR, or approved equal.
   3. Box: Provide as hereinafter specified.

B. Installed indoors inside STORAGE ROOMS and PROCESS MECHANICAL EQUIPMENT ROOMS and installed in ALL OUTDOOR AREAS:
   1. Specification grade
   2. 2-wire, 3-pole, rated 20 amp, 120 volt,
   3. Twist-lock, factory-sealed, pin and sleeve
   4. Internal horsepower and AIC-rated switch that shall activate only after the Plug is inserted into the receptacle and twisted.
   5. Dead-front, mechanically interlocked where plug cannot be engaged or disengaged under load.
   6. Brass receptacle blades/contacts
   7. Watertight, raintight and corrosion resistant and rated for use in Class I Division 2 hazardous areas.
   8. Fully gasketed, watertight, dustight and corrosion resistant twist-on cover.
   9. Type 12 nylon enclosure with 316 stainless steel hardware

10. Manufacturer: Cooper Crouse-Hinds Series IEC-309 Hazardous Area Receptacles/Plugs and Interlocks, Factory-Sealed, TYPE GHG Pin and Sleeve receptacles complete with device boxes and specified accessories.
11. Furnish and install a total count of Two (2) Sets of completely assembled matching CORD and PLUG assembly for the Pin and Sleeve Receptacles. The cord and plug assembly (of each set) shall consist of:
    a. Matching Male Plug manufactured by Cooper Crouse-Hinds Series IEC-309 Hazardous Area Plugs and Interlocks, Factory-Sealed, TYPE GHG Pin and Sleeve Twist-On plug
    b. 25-feet of #12AWG, 3-conductor extra-flexible Type SO-CORD power cord (each conductor shall be 100%-conductive-soft-copper conductors with 41-strands).
    c. NEMA 5-20R Female Connector, 20-amp, 125 volt rated having tin-plated-copper spade-connectors.

2.03 DEVICE ENCLOSURES AND COVERPLATES

A. Installed indoors inside the environmentally and climate controlled ELECTRICAL ROOMS:
    1. Enclosures for exposed surface mounted devices:
        a. Sand Cast Aluminum, 99.0% copper-free, one piece construction, suitable for surface mounting
        b. Single and Multi-Gang Weatherproof Outlet boxes, as required.
        c. 3/4-inch threaded hubs, minimum box depth shall be 2-5/8". Use 2-3/4" depth when "gang" arrangements of outlets are used.
        d. Manufacturer: Crouse-Hinds Series FS or FD, Appleton, or approved equal.
    2. Enclosures for recessed flush mounted devices:
        a. Concrete Masonry Unit block wall type Steel Boxes.
        b. Minimum box depth shall be 3-1/2".
        c. Where required, furnish masonry concrete type steel ring/ Adapter Plate cover/ and Back Plates.
        d. Manufacturer: Hubbell, or approved equal by Raco.
    3. Coverplates:
        a. Switches: Die Cast Aluminum, 99.0% copper-free, gasketed coverplate with external operating handle for on-off operation (with hole for lock), as manufactured by Crouse-Hinds or approved equal.
        b. Receptacles: Die Cast Aluminum 99.0% copper-free, complete with rubber gasket, as manufactured by Crouse-Hinds WLRS (single cover), WLRD (duplex cover), WLGF-FS and WLGF-FSV (GFCI cover) or approved equal.

B. Installed indoors inside STORAGE ROOMS and PROCESS MECHANICAL EQUIPMENT ROOMS and installed in ALL OUTDOOR AREAS:
    1. Enclosures:
        a. Sand Cast Aluminum, 99.0% copper-free, one piece construction, suitable for surface mounting
        b. Single and Multi-Gang Weatherproof Outlet boxes, as required.
        c. 3/4-inch threaded hubs, minimum box depth shall be 2-5/8". Use 2-3/4" depth when "gang" arrangements of outlets are used.

d. Manufacturer: Crouse-Hinds Series FS or FD, Appleton, or approved equal.

2. Coverplates:
   a. Switches: Die Cast Aluminum, 99.0% copper-free, watertight and corrosion resistant and having an external front operator (for snap switches). In a group installation, provide manufacturer's assemblies for two gang tandem, three, four and/or five gang bodies (device boxes). Light switch covers shall be as manufactured by Crouse-Hinds, Killark, or approved equal.
   b. Receptacles: See Part 2.02 B this Section of the Specifications.

2.04 DUPLEX SCADA RECEPTACLES

A. General: Shall be provided complete with receptacle, box, and coverplate with the following features:
   1. Faceplates shall be available with multiple module spaces for both vertical and horizontal applications. Each faceplate shall accept individual modules for both copper and fiber optic applications. Faceplates shall be flush mounted with a clean look and be available with labels. Faceplate color shall be white. For each faceplate, furnish and install a minimum of four (4) MINI-COM TX6A 10GIG UTP Jack Modules as manufactured by Panduit. Data outlet faceplate shall be manufactured by Panduit with Four Module Space, model CFPL4 with white color. Furnish and install data label with plastic cover as manufactured by Panduit. Provide label and clear plastic cover as manufactured by Panduit for all mini com modules. Label each non-blank mini com device data outlet on each face plate with indelible, permanent printing system with black color imprinted ¼" high capital lettering attached to faceplate and covered by plastic clear cover, as manufactured by Panduit. Submit proposed data labeling for review and approval by OWNER and ENGINEER prior to commencing data labeling. Clearly distinguish SCADA data outlets from other data outlets using color coded mini com data outlet color and faceplate icon color. Coordinate with OWNER for color preference of the data outlets and icons.

B. Box: Provide as hereinafter specified. Exception: The coverplate required by subsection 2.03, this Section of the Specifications, is not required for these receptacles.

2.05 MISCELLANEOUS

A. All mounting hardware shall be Type 316-stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mounting: Device enclosures shall be surface mounted on conduit support channels per Section 16150 and as shown on the PLANS.

B. Mounting heights shall be as follows unless otherwise noted on the PLANS:
   1. Light switches: 48 inches above finished floor to center of switch

2. Receptacles: 36 inches above finished floor to center of receptacle.

C. Tagging:
   1. Tag all receptacles and switches
   2. Tagging format: “ckt. LPY-XX” where Y represents the panel number (e.g. for panel “LP-01”, Y is 1) and XX represents the circuit number. Add voltage if other than 120V.
   3. Tag type:
      a. Type: 3-ply, 1/8” thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
      b. Color: White-Black-White.
      c. Lettering: Engraved through the face layer to the melamine middle layer.
      d. Accessories: adhesive backplane.

D. Provide 6-inches offset for receptacles or other wiring devices mounted on opposite sides of a wall.

E. Do not use switch boxes as junction boxes for switch and receptacle.

F. Set box square and true with building surfaces.

G. Maintain symmetry of all devices as closely as possible within the Architectural Section contained. For example, center a light fixture over a doorway, or a receptacle in a section of wall, if shown in that approximate position.

H. Verify location of receptacles and switches in finished rooms. In centering devices and locating device boxes, allow for overhead pipes, and mechanical equipment; etc., and correct any inaccuracy from failure to do so without extra expense to the OWNER.

I. Cap all device boxes not used under this Contract with blank outlet covers.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 16350

LIGHTING

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install lighting fixtures, outdoor lighting photocells, and electrical lighting contactors as specified herein and as indicated on the PLANS.

B. Refer to the lighting fixture schedule shown on the PLANS for a listing of proposed lighting fixtures and other requirements. The lighting fixture schedule shown on the PLANS is not inclusive of all equipment required by this Contract. Refer to Part 2 of this section for additional requirements.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the number of lighting fixtures and other requirements for the proposed equipment specified under this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Contract Specifications. Submit a lighting fixture brochure for each fixture indicating catalog number, pertinent physical characteristics, and complete photometric data.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. O&M Manuals shall include copies of the approved shop drawings, factory and on-site/field test data.

1.04 SPARE PARTS

A. Provide quantities of spare parts as follows:
   1. Spare LED lamp modules: Five percent spare LED lamp modules for each fixture type specified, with minimum of 3 lamp modules of each type.
   2. Spare Drivers: Five percent spare drivers for each fixture type specified, with minimum of 6 drivers of each type.

3. Spare Ballasts: Five percent spare ballasts for each fixture type specified, with minimum of 6 ballasts of each type.

PART 2 PRODUCTS

2.01 GENERAL

A. General:
   1. Furnish and install fixtures in accordance with the requirements of this specification and the requirements of the PLANS. Fixtures shall bear the U.L. label and such labels shall apply to entire fixture as installed.
   2. Deliver lamps to job site in original cartons. Lamps shall be as manufactured by General Electric, Sylvania, or approved equal.

2.02 LIGHT FIXTURES

A. General: Multiple types of light fixtures are required for this project and as described hereinafter. Refer to the PLANS for application of the specific light fixture types.

2.03 ACCESSORIES

A. Deliver all fixtures complete with suspension chains, accessories, canopies, hickeys, casings, sockets, holders, reflectors, ballast, diffusers, frames, recessing boxes, etc.

2.04 PROTECTION

A. Protect all fixtures, lenses and louvers from damage. Leave protective coverings on lenses and louvers until fixtures are installed. Replace all damaged lenses and louvers immediately prior to final inspection at no cost to the OWNER.

2.05 SUBSTITUTIONS

A. Comply with requirements of the Contract Specifications.

2.06 LIGHTING CONTROL PANEL

A. Furnish and install totally enclosed Lighting Control Panels and associated controls, as specified hereinafter and as shown on the PLANS.

B. General:
   1. Contactor Type: Solid-state
   2. Number of Poles and Configuration: Single pole single throw
      a. Quantity of single pole Contactors as shown on the PLANS.
   3. Current Rating: 43 amperes
   4. Rated Power: 10 horsepower at 600 volts A.C.
   5. Certifications: U.L. listed
   6. Symmetrical Short Circuit Rating: Minimum of 100,000 ampere at 600 volts A.C. unless shown to be greater on the PLANS.
   7. Operational Voltage: 600 volts A.C. maximum

8. Control Coil Voltage: 120 volts A.C.
9. Control Input Status: Continuously ON Green LED, when control input is applied
10. Operating Temperature: -40°F to +176°F
11. Mounting: DIN rail
12. Accessories:
    a. Wire lighting control panel per manufacturer's standard to facilitate the control logic as shown on the PLANS.
    b. Hand-Off-Auto selector switch:
        1) In accordance with the requirements of Section 16540 "Field Control Stations".

C. Enclosure: In accordance with the requirements of Section 17200 "Instrumentation and Control Cabinets and Associated Equipment".

D. Manufacturer: Allen-Bradley Bulletin 156-C1P43NCB with specified accessories, or approved equal.

2.07 PHOTOCELL FOR OUTDOOR AND PERIMETER LIGHTING CONTROL

A. Style: Factory sealed

B. Operating Voltage: 120VAC, dry contact output

C. Ambient Temperature: 40°C, T3 rated

D. Material: Aluminum

E. Certification: Class I Division 1, Class II Division 1 and 2, NEMA 4X

F. Enclosure:
1. Cast copper-free aluminum alloy with electrostatically applied silver powder epoxy paint finish.
2. 3-1/2 inch male threaded box opening with O-ring sealing gasket
3. Internal ground screw
4. 3/4 inch NPT conduit openings
5. Certification: Class I Division 1 and 2, UL Listed
6. Manufacturer: Killark series HKB-GL, or approved equal

G. Manufacturer: Hubbell-Killark Catalog No. VMHKPC1 with specified enclosure, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION AND TESTING

A. Maintain perfect horizontal and vertical alignment of fixtures throughout.

B. Do not locate circuiting splices or taps within an arm, stem or chain.

C. Replace any damaged fixture or lens at no cost to the OWNER.

D. Support all pendant fixtures with swivel type hangers.

E. Install recessed luminaries to permit removal from below, to gain access to outlet or prewired fixture box.

F. Locate fixtures where shown on the PLANS and coordinate fixture location such to avoid interference with piping, fans, ducts, and other obstructions. Obtain approval of any location differing from the location shown on the PLANS.

G. Furnish and install outlet box for photocell mounting as specified in Section 16300 “Wiring Devices”. Orient and make wiring connections to photocell per photocell manufacturer’s recommendations.

H. Lighting fixtures shall not be used as raceways for conductors that do not supply the connected fixtures.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 16444

COMBINATION MOTOR STARTERS

PART 1 GENERAL

1.01 SUMMARY

A. Scope of Work
   1. The Contractor shall furnish and install the combination motor starters as specified herein and as shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The PLANS designate the type, number, size and rating of devices included in the combination motor starters.

B. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of the Contract Specifications. Include:
   1. Dimensioned/scaled top and bottom views, front elevations
   2. One-line diagrams and wiring diagrams,
   3. Catalog cut sheets. Include protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable.
   4. Temperature rating information for the solid-state starters.

B. Operation and Maintenance Manuals
   1. Furnish Operation and Maintenance Manuals in accordance with the requirements of Section 01730 of the Contract Specifications. Include:
      a. Installation and operation manuals.
      b. Renewal parts bulletin.
      c. As built drawings, including approved shop drawings.
      d. Test data.

1.04 QUALITY ASSURANCE

A. All Combination Motor Starters on the project shall be manufactured by a single Combination Motor Starter manufacturer. The manufacturer of the Combination Motor Starters shall also manufacture the majority of components and subsystems therein (i.e., circuit breakers, starters, controls relays, etc.)

B. The Combination Motor Starters shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, UL, and NEC standards.

C. Combination Motor Starters shall be as manufactured by Square D Company, General Electric Company “G.E.”, Allen-Bradley, or Cutler Hammer Corporation.

1.05 DELIVERY, STORAGE AND HANDLING

A. Protection
   1. The Contractor, and hence the Combination Motor Starters supplier, shall be responsible for safety of the Combination Motor Starters during storage, transporting and handling.
   2. At all times the Combination Motor Starters shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   3. Interior and exterior of Combination Motor Starters shall be kept clean at all times.
   4. Energize the space heaters within the Combination Motor Starter and energize during storage and installation for humidity control.

1.06 TOOLS AND SPARE PARTS

A. Furnish the following spare parts with the equipment for each Combination Motor Starter in conformance with the specifications:
   1. One (1) – Set of fuses (minimum 2) for each type and size used.
   2. One (1) – Set of starter contacts for each size used. If contacts are not replaceable a spare starter for each size used shall be supplied.
   3. One (1) - Contactor coils for every NEMA size and type starter installed, a minimum of one coil per size.
   4. One (1) - Spare control relays for each type used. Control relay shall be furnished complete with relay coils, Four (4) Normally Open (N.O.) contacts, Four (4) Normally Closed (N.C.) contacts, and shall be furnished with Relay Manufacturer’s Transient Voltage Suppression Module.
   5. One (1) - Spare timing relay.
   6. Two (2) – Sets of overload heaters for each size and type used.

1.07 SPECIAL MANUFACTURER’S SERVICES

A. Prepare a harmonic, arc-flash, motor starting, and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16140 of the Specifications “Switchboards”, paragraph 1.08 “Special Manufacturer’s Services”.
   1. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to assist in the installation of the equipment. Include checking alignment of parts, wiring connections, operation of all parts (relays, starters, monitoring relays, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the Owner with a report certifying that the equipment was installed properly tested and set in accordance with the specifications and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications.
   2. Manufacturer's technical representative is to set, adjust and test all protective relays, etc. in the presence of a representative of the OWNER. The settings will be based on coordination and short circuit studies performed in compliance with Section 16140 of the Specifications “Switchboards”,

paragraph 1.08 “Special Manufacturer’s Services”. Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.

PART 2 PRODUCTS

2.01 GENERAL

A. For additional construction notes and special requirements, refer to the PLANS. Also refer and adhere to the requirements of the PLANS.

B. Combination Motor Starters shall not exceed the dimensions shown on the PLANS.

2.02 CONSTRUCTION

A. Enclosure:
   1. General:
      a. Enclosure shall have a hinged door with padlockable disconnect operating handle. Include provisions for up to three padlocks. Handle shall be mechanically interlocked with the door to prevent personnel from opening the door when the disconnect is in the ON position. Provide handle-door interlock defeating (bypass) feature.
      b. Include lugs for the connection of the field wiring shown on the PLANS.
      c. Where available from the manufacturer, exterior openings shall be screened to prevent the entrance of small animals, insects, etc.
   2. Combination Motor Starter assemblies installed INDOORS:
      a. Enclosure: NEMA-12, gasketed
      b. Finish: Primed and painted using the manufacturer’s standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be ANSI #61 Gray finish
   3. Combination Motor Starter assemblies installed OUTDOORS:
      a. Enclosure: 316 stainless steel, NEMA 4X, gasketed, suitable for outdoor use.

B. Ground Bus
   1. A tin plated ground bus shall be furnished for each Combination Motor Starter. The ground bus shall be rated for 50 percent of the main power (phase) rating of the starter, at minimum. Provide ground bolted connectors for the size and quantity of wire at each end of the bus.

C. Wiring
   1. All wiring shall be stranded copper not smaller than No. 14 AWG.
   2. All wiring shall be neatly bounded with tie-wraps and supported to wire ways supports.

D. Identification
   1. All component and control identification labels shall include the device name and number exactly as it appears on the PLANS. Refer to the PLANS.
   2. All control wires shall be tagged and coded with an identification number. Tagging type and wire coding shall be per manufacturer's standard.
   3. All terminal blocks shall be identified.
   4. Properly label the devices mounted inside each section using manufacturer's standard laminated labels installed in accordance with the manufacturer's standard method.
   5. Furnish and install laminated 3-ply "White-Black-White", phenolic identification nameplates with engraved lettering. Attach nameplate with screws/bolts per manufacturer's standard; use of adhesives shall not be accepted. Furnish and install nameplates for:
      a. Each equipment/device/etc. installed/mounted on the face of the Combination Motor Starter.
      b. Overall nameplate for the exterior of each Combination Motor Starter.

2.03 COMBINATION UNITS

A. Each combination motor controller and feeder unit shall have the following characteristics:
   1. Molded case circuit breakers for branch circuit protection. Circuit breakers shall have the following characteristics:
      a. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the bus serving the starter, unless otherwise shown on the PLANS.
      b. Three pole, 600 volt, type and maximum continuous current carrying capacity as shown on the PLANS.
   2. Starters shall have the following characteristics:
      a. Starters shall be magnetic type, NEMA rated, with 120 volts A.C. operating coils. International type starters (IEC rated), will not be accepted, even if the starters were to show equivalent NEMA ratings.
      b. Size and configuration (full voltage non-reversing, full voltage reversing, reduced voltage solid state, etc.) as shown on the PLANS.
      c. Provide each starter coil with the manufacturer's standard transient voltage surge suppression module.
      d. Provide auxiliary contacts as required by the PLANS. Contacts shall be rated for 120 volts A.C and shall satisfy the requirements of the PLANS. Provide each starter with one (1) normally open auxiliary contact wired to terminal blocks over the number of contacts required by the PLANS.
   3. Provide Overload relays where required by the PLANS. Overload relays shall have the following characteristics:
      a. Standard class 20, ambient compensated,
      b. Manually reset by push-button located on front of the compartment door.
      c. Provide with auxiliary contact rated for 120 volts A.C. Contact shall satisfy the requirements of the PLANS.
      d. The overload relay heaters will be selected by the Contractor after delivery of the Combination Motor Starter. Include all necessary delivery, packaging, and administrative costs associated with the delivery of overload heaters.

4. Control Power Transformer. The transformer shall have the following characteristics:
    a. Adequately sized to serve all loads shown on the PLANS. Minimum size shall be 200VA, unless noted otherwise on the PLANS.
    b. Connect as shown on the PLANS.
5. Provide one single pole fuse block with fuse for each motor space heater.
6. Provide additional requirements as shown on the PLANS.

2.04 MISCELLANEOUS ACCESSORIES

A. Control relays shall have the following characteristics:
1. 600 volts, standard NEMA Size, AC Heavy-Duty industrial type with 120 volt AC coils.
2. Minimum contact rating of 10A, continuous, at 120 volts AC.
3. Furnish each relay with one additional Normally Open (N.O.) and one additional Normally Closed (N.C.) contacts over the number required by the PLANS.
4. Provide each relay with Relay Manufacturer's Transient Suppression Module.
5. Relays shall be "Allen Bradley Bulletin 700", Type-700P, or equal relays of the combination motor starter manufacturer.

B. Timing Relays shall have the following characteristics:
1. Solid state, multi-time, and multi-function type relay
2. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes:
    a. On Delay
    b. Off Delay
    c. One Shot
    d. Repeat Cycle
    e. Interval
3. Minimum relay contact rating shall be 10 amps, continuous, at 120 VAC.
4. Timing relays shall be Square D Class 9050 model No. JCK70 complete with Type NR61 Socket, or equal timing relays of the combination motor starter manufacturer.

C. Pushbuttons, Selector Switches, Pilot Lights
1. Rating: NEMA 4X/13, heavy duty, oil tight/corrosion resistant, hermetically sealed and rated for use in wet locations and in Class I Division 2 hazardous areas (as classified by NEC).
2. Size: NEMA Style full size 30-millimeter (30mm),
3. Contacts: 5 ampere minimum at 120 volts A.C. Hermetically sealed and stackable contact blocks. Provide number of contacts to satisfy the requirements of the PLANS.
4. Legend Plate: Provide per manufacturer's standard with inscription as shown on the PLANS.
    a. Manufacturer: Allen Bradley Bulletin 800R, or approved equal.
5. Additional Requirements for Selector Switch/ Pushbuttons:
    a. Operator Color: Black, unless shown otherwise on the PLANS.
    b. Selector Switch Action Type: Maintained action, unless shown otherwise on the PLANS.

c. Pushbutton Action Type: Momentary action, unless shown otherwise on the PLANS.

6. Additional Requirements for Pilot Lights:
   a. Type: Transformer Type Light Emitting Diode (LED),
   b. Voltage: 120 volts A.C.
   c. Style: Push-to-test
   d. Lens Color: Refer to the PLANS.

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TEST

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Install per manufacturer's instructions and recommendations. Install all required safety labels.

B. Perform manufacturer's field services as previously specified

C. Size, furnish and install the overload relay heaters based on actual motor nameplate current. Set overload relay settings at maximum values permitted by the NEC 430-32.

D. Size, furnish and install the motor space heater fuses based on actual motor space heater load current.

E. Surface mount Combination Motor Starter units where the top of each unit is no higher than 6-feet-6-inches above the finished floor elevation, unless otherwise noted on the PLANS. Mount free standing Combination Motor Starters on an equipment pad as shown on the PLANS.

3.03 FIELD TEST AND CHECKS

A. Verify proper rotation of all motor loads

B. Verify motor space heater circuits are operational.

C. Verify functional operation of the applicable starter control logic circuitry.

D. Submit documentation of all tests outlined above.

E. Submit manufacturer's certification report per sub-section 1.07, this Section of the Specifications.

3.04 EQUIPMENT PROTECTION AND RESTORATION

A. Clean and vacuum all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

3.05 TRAINING

A. Provide training sessions for owner's representatives for four (4) normal work hours at the job-site location and/or at a location determined by the OWNER. If training is conducted in less than the time required by these specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the Combination Motor Starter manufacturer's non-sales-type technical representative, who performed the field installation and start-up/setting/adjustment services.

C. At minimum, the training session shall include:
   1. Operation and maintenance procedure for the equipment and all components installed within the starter.
   2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.
   3. Potential of arc-flash hazards associated with working on energized equipment.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 16450

600 VOLTS AND BELOW DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install dry type transformers as specified herein and as shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the number, size and rating of transformers required.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300 of the Specifications. For each individual Transformer include:
   1. Dimensioned/scaled plan view and elevation
   2. Ratings, product data sheets, including weight and nameplate data
   3. Wiring connection diagram

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. Include:
   1. Copies of the approved shop drawings
   2. Factory and on-site/field test data.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, receive, unload and handle equipment by suitable methods. Inspect for damage before accepting shipment. Wrap in protective plastic wrapping and store in climate controlled (temperature and humidity, etc.) environment. Use heat lamps as necessary to prevent condensation.

1.05 ACCEPTABLE MANUFACTURER

A. General Use (Power & Lighting) Dry-Type Ventilated Isolation Transformers shall be Watchdog Premium Quality units manufactured by Square D (Schneider Electric) class 7400, or approved equal.

B. Ultra-Isolator, Highly Shielded and Noise and Transient Voltage Suppressing Transformers IN ALL AREAS: shall be as manufactured by “Eaton” Power-Suppress T7 Series 30 Ultra-Isolation Transformers with “K” Factor 13 Rating (with electrostatic shielding) and all other specified accessories, or approved equal.

PART 2 PRODUCT

2.01 GENERAL AND BASIC REQUIREMENTS FOR ALL 600 VOLT AND BELOW DRY TYPE TRANSFORMERS

A. Type:
   1. Manufacturer's premium quality dry type transformers.
   2. Primary and secondary voltage ratings, and, KVA ratings to be as shown on the PLANS.
   3. All windings shall be copper.
   4. Transformers shall be of ventilated type.

B. Core and coils:
   1. Continuous wound core impregnated with non-hygroscopic, thermosetting varnish.
   2. Core to be of high grade, non-aging silicon steel with high magnetic permeability.
   3. Core and coil bolted to base of enclosure but isolated from it by rubber vibration absorbing mounts.

C. Additional Requirements:
   1. Furnish with four (4) 2-1/2 percent full capacity primary taps, two (2) above and two (2) below rated primary voltage.
   2. Core is to be visibly grounded to enclosure by means of a flexible grounding conductor sized per NEMA, IEEE and ANSI standards.
   3. All transformers shall be U.L. listed and certified and carry the U.L. label.
   4. Sound levels: Guaranteed not to exceed the following:

Transformer KVA Range	Sound Level
15 to 50KVA	45dB
51 to 150KVA	50dB
151 to 300KVA	55dB

2.02 GENERAL USE (POWER & LIGHTING) VENTILATED DRY TYPE ISOLATION TRANSFORMERS

A. General:
   1. Transformers shall be suitable for indoor installation. Comply with all requirements/specifications outlined in subsection 2.1, above (Basic and General Requirements for All 600 volt and Below Dry Type Transformers).

2. Transformers shall meet NEMA TP-1 efficiency requirements.

B. Temperature Rise and Insulation System:
   1. Temperature Rise: 80 degrees Celsius above a 40 degree Celsius. ambient
   2. All insulating materials shall be in accordance with NEMA ST20 standards for a 220 degree Celsius. U.L. component recognized insulation system.

C. Enclosure: Heavy gauge sheet steel with ventilation openings designed in accordance with U.L., NEMA and the N.E.C. Phosphatized, primed and finished with ANSI #61 gray, baked enamel. Provide surface/wall mounting brackets where surface/wall mounting is shown on the PLANS.

2.03 CONTROL AND INSTRUMENT POWER ULTRA-ISOLATOR, HIGHLY SHIELDED AND NOISE AND TRANSIENT VOLTAGE SUPPRESSION TRANSFORMERS

A. General:
   1. Transformers shall be of the dry type suitable for indoor installation. Comply with all specifications requirements outlined in subsection 2.01, above (Basic and General Requirements for All Dry Type Transformers) in addition to the requirement specified in this subsection 2.03. Note: Requirements hereinafter specified take precedence over the requirements outlined in subsection 2.01 above.

B. Ratings:
   1. Input Voltage Range: Plus or minus 10 percent of nominal.
   2. Isolation: All winding are to be electrically isolated from each other
   3. Temperature Rise and Insulation System:
      a. Temperature Rise: 115 degrees Celsius above a 40 degree Celsius. ambient.
      b. All insulating materials shall be in accordance with NEMA ST20 standards for a 200 degree Celsius. U.L. component recognized insulation system.
   4. Load Regulation: 3.5 percent or less from no load to full load at unity power factor.
   5. Frequency Range: 57 Hz to 63 Hz.
   6. Overload Capacity: 500 percent for one cycle with no adverse effects
   7. Harmonic Distortion: 1 percent added to the output waveform, at maximum
   8. Efficiency: 95 percent at all load levels, at minimum.
   9. Maximum Audible Noise: Less than 50 dBA measured at a distance of 3-feet.
   10. Common-Mode Noise Attenuation: 120 dB minimum
   11. Peak Transient Current: 15,000 amps (8 x 20 microsec. Wave)
   12. Maximum Clamping Voltage: 350 volts at 300 amps
   13. Pulse Transient Energy: 200 joules
   14. Shielding: 100 percent electrostatic shield wound between the primary and secondary windings. Shield must be connected to a terminal inside the transformer enclosure.
   15. “K” Factor Rating: 13, U. L. Listed.

C. Enclosure: Heavy gauge sheet steel with ventilation openings designed in accordance with U.L., NEMA and the N.E.C. Phosphatized, primed and finished with gray baked enamel.

2.04 NAMEPLATES

A. General:
   1. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   2. Color: White-Black-White
   3. Lettering: 3/8 inch height, minimum, engraved through the face layer to the melamine middle layer.
   4. Accessories: Provide holes for mechanical fastening.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install at the locations shown on the PLANS in accordance with manufacturer's recommendations. Furnish and install equipment pads as shown on the PLANS for floor mounted transformers and surface/wall mounted brackets for surface/wall mounted transformers as required.

B. Make grounding connections as required by the N.E.C. and as shown on the PLANS.

C. Tagging:
   1. Tag each transformer with the name as it appears on the PLANS using the specified nameplates attached with stainless steel screws. Include the following additional information: name of the load served by the transformer, primary voltage rating, secondary voltage ratings, KVA rating, phase, wire, primary and secondary winding configuration, and transformer type.

3.02 TESTS AND INSPECTIONS

A. All test results (including factory test) shall be certified.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 16483

480 VOLT VARIABLE FREQUENCY DRIVE

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required to provide, and make ready for operation, the 480 Volt Variable Frequency Drives (LVVFD's) as specified herein and as shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.

C. The PLANS designate the size, rating, and other requirements of the equipment specified under this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 QUALIFICATIONS

A. All LVVFDs provided as part of this project shall be manufactured by a single LVVFD manufacturer. The manufacturer of the LVVFDs shall also manufacture the majority of components and subsystems therein (e.g., circuit breakers, starters, controls relays, etc.).

B. The LVVFDs shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, UL, and NEC standards.

C. LVVFDs shall be as manufactured by Square D Company, Allen-Bradley, Cutler Hammer Corporation, or Asea Brown Boveri.

1.04 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Specifications. Submittals shall include:
   1. Dimensioned/scaled top and bottom views, front elevations, and internal component/device layouts
   2. One-line and wiring diagrams
   3. Catalog cut sheets

4. LVVFD frequency spectrum characteristic curves indicating LVVFD input current and voltage harmonic content for LVVFD loadings of: 25, 50, 75 and 100 percent of full load. Submit LVVFD maximum heat loss.
5. Harmonic filter characteristic curves and rating catalog data sheets for major filter subcomponents (line reactors, tuning reactors, and capacitors) for the family of harmonic filters specified. Submit harmonic filter maximum heat loss. Submit compliance with minimum harmonic filter performance requirement and additional related information, as applicable, as described in this Section of the Specifications.
6. As a minimum, the Contractor shall provide the recommended LVVFD type (Constant Torque, Variable Torque) to the LVVFD manufacturer in accordance with the pump/motor manufacturer's recommendations and requirements necessary for the pump/motor manufacturer to satisfy the driven equipment performance requirements. Submittals shall reflect the recommended LVVFD type provided by the Contractor.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Furnish Operations and Maintenance Manuals (O&M) in accordance with Section 01782 of the Specifications. Include:
   1. Copies of certified and approved shop drawings.
   2. Detailed information on each component used, including:
      a. Installation and operation manual.
      b. Renewal parts bulletin.
      c. As built drawings, including approved shop drawings.
      d. Test data.

1.06 STORAGE AND HANDLING

A. Protection
   1. The CONTRACTOR, and hence the LVVFD supplier, shall be responsible for safety of the LVVFDs during storage, transporting and handling.
   2. The LVVFDs shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
   3. At all times the LVVFDs shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   4. Interior and exterior of the LVVFDs shall be kept clean at all times.
   5. Energize the space heaters within the LVVFDs during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:
   1. Environmentally protected and stored in climate controlled (temperature and humidity) environment at the job site. Size, furnish and install temporary air conditioners, and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
      a. Ambient Dry Bulb Temperature:
         1) Minimum: 68 degrees Fahrenheit.
         2) Maximum: 85 degrees Fahrenheit.
      b. Ambient Relative Humidity: Maximum: 50%

2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
3. Upon arrival of equipment onto job site, the Contractor shall provide proper transition of power to equipment, especially any 120 VAC powered equipment, to ensure all air conditioning and heating equipment are fully operational and that the equipment is in a conditioned space on the day the equipment arrives.

1.07 SPARE PARTS

A. Furnish the following spare parts with the equipment for each LVVFD in conformance with the specifications:
1. One (1) set (minimum 3) of fuses for each type and size used
2. One (1) set of spare starter contacts for each type and size used. If contacts are not replaceable a spare starter for each size used shall be supplied.
3. Two (2) Contactor coils for every NEMA size and type starter installed, a minimum of one coil per size.
4. Two (2) spare control relays for each type used. Control relay shall be furnished complete with relay coils, Four (4) Normally Open (N.O.) contacts, Four (4) Normally Closed (N.C.) contacts, and shall be furnished with Relay Manufacturer's Transient Voltage Suppression Module.
5. One (1) spare timing relay
6. Two (2) sets of overload heaters for each size and type used
7. Provide breaker test set for Solid-State-Trip units for each type used
8. One (1) spare Power Monitoring Unit as specified in Section 2.05, this Section of the Specifications
9. One (1) quart of touch-up paint

1.08 SPECIAL MANUFACTURER'S SERVICES

A. Prepare a harmonic, arc-flash, motor starting, and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services".

B. Furnish the services of a qualified, experienced, factory trained technical (non-sales type) representative to assist in the installation of the equipment. Include checking alignment of parts, wiring connections, operation of all parts (relays, starters, monitoring relays, etc.). Include time to correct and recheck any discrepancies which are discovered. Also include providing the Owner with a report certifying that the equipment was installed properly tested and set in accordance with the specifications and is in satisfactory operating condition. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications.

C. Manufacturer's technical representative is to set, adjust and test all protective relays, etc. in the presence of a representative of the OWNER. The settings will be based on coordination and short circuit studies performed in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services". Provide the OWNER with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications. The Manufacturer

shall furnish the protective device of the appropriate characteristics that shall be the most suitable for the proper protection and coordination of the system at No Additional Cost to the OWNER.

D. Any problems encountered with the operation of equipment, parts, components, etc. installed within the LVVFD line-up shall be repaired/remedied by the manufacturer's technical representative at no additional cost to the Owner.

E. The LVVFD harmonic performance shall meet the following minimum performance requirements at the location identified on the PLANS:
   1. Compliance with latest version IEEE 519, with the location identified the PLANS serving as the IEEE 519 “point of common coupling”
   2. Should a harmonic filter (i.e., reactor, transformer, etc.) be required to meet the above harmonic performance requirements, the OWNER will select the characteristics of the harmonic filter that are most suitable for the system in providing compliance to the harmonic performance requirements. The selection will be based in part on the harmonic study performed in compliance with Section 16140 of the Specifications “Switchboards”, paragraph 1.08 “Special Manufacturer’s Services”. The Manufacturer shall furnish the harmonic filter of the appropriate characteristics that shall be the most suitable for the proposed operation of the system at No Additional Cost to the OWNER.

PART 2 PRODUCT

2.01 GENERAL

A. For additional construction notes and special requirements, refer to the PLANS. Also refer and adhere to the requirements of the PLANS.

B. LVVFD shall not exceed the dimensions shown on the PLANS. Compartment/component arrangement shall be as shown on the elevation drawings. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below, as shown on the PLANS

C. The LVVFD manufacturer shall make any modifications required to its standards in order to accommodate for the type of installation and design criteria required for the specific application necessary for this project.

2.02 CONSTRUCTION

A. Structure:
   1. Each LVVFD shall consist of a rigid, self supporting free-standing assembly enclosed in a NEMA –1A rated enclosure with additional requirements as shown on the one-line diagrams and other drawings shown in the PLANS. The structure shall be not more than 90 inches nominal height, and be fabricated of formed steel of not less than 14 gauge thickness.
   2. Front mounted (dead front) units, where specified, shall not require rear access and shall be suitable for back-to-wall mounting. All wiring, bus joints, and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.

3. Holes or slots provided in wire ways or other metal members for routing of wires shall be provided with bushings or grommets to avoid damage to the wiring insulation.
4. The LVVFD shall be provided with gasketed front hinged doors. The controller/starter units shall be interlocked mechanically with a unit disconnect device to prevent unintentional opening of the door while unit is energized. Means shall be provided for releasing the interlock for intentional access and/or application of power. Pad locking arrangements shall permit locking the disconnect device in the "OFF" position.
5. The LVVFD shall be furnished as completely factory assembled unit where transportation facilities and installation requirements permit. Minimize shipping splits if required.
6. All painted steel work shall be treated with a primer coat and a finish coat, or bonderized and furnished with a coat of baked enamel at the factory, such that no field painting will be required except for "touching up" of damaged areas. Color shall be manufacturer's standard.
7. Furnish documentation with equipment as follows: compartments containing motor starters shall each have an overload heater section table posted inside the door. All control compartments shall have a pocket on the inside of the door with a copy of the appropriate schematic and wiring diagram.
8. Provide screw on type engraved laminated nameplates as follows: Main equipment nameplate shall be located at the top of the LVVFD near the main breaker compartment. Individual compartment nameplates shall be screwed to their respective doors. A manufacturer's plaque shall be attached to the LVVFD giving model number, bus amps, voltage, maintenance reference documents, and other applicable information.
9. The LVVFD shall include at least one 120 volt, fused 250 watt space heater with a dedicated thermostat wired to terminal blocks in the respective section. Wire to the space heater control power transformer described in subsection 2.04 D. below.
10. Furnish lugs for incoming line feeders, quantities and sizes shall be as required by the electrical one-line diagrams and conduit/wire schedules shown on the PLANS. Allow adequate clearance for bending and terminating to cable type specified.

B. Buses
1. A tin-plated copper ground bus shall be furnished for the LVVFD. The ground bus shall be rated for 50 percent of the main protective device (frame) rating, at minimum. Provide ground bolted connectors for the size and quantity of wire at each end of the bus as shown on the PLANS.

C. Wiring:
1. All control wiring shall be stranded copper not smaller than No. 14 AWG.
2. All wiring shall be neatly bounded with tie-wraps and supported to wire ways supports
3. All control wiring to shall run through terminal blocks. Provide low density, 600 volt, 30 ampere rated NEMA type tubular terminal blocks. Motor "T" leads shall bolt directly to starter or overloads.
4. One spare Normally Open (N.O.) and one Normally Closed (N.C.) contact on all relays, selector switches, push buttons, "M" contact, alarm points, etc. shall be wired to terminal blocks.

5. Where “shipping splits” are required between the control compartments and the starters cubicles, interconnecting jumper wires shall be provided for field re-connection.

D. Identification:
   1. All component and control identification labels shall include the device name and number exactly as it appears on the PLANS. Refer to the PLANS.
   2. All control wires shall be tagged and coded with an identification number. Tagging type and wire coding shall be per manufacturer’s standard.
   3. All terminal blocks shall be identified.
   4. Properly label the devices mounted inside of each section using manufacturer’s standard laminated labels installed in accordance with the manufacturer’s standard method.
   5. Properly label each exterior section/compartment of each MCC with laminated 3-ply phenolic, “Black-White-Black”, plastic nameplates, a minimum of 3/32-inch thick, with white Roman Gothic lettering on black background. Attach nameplate with screws/bolts per manufacturer’s standard. Minimum lettering size of identification nameplates located on the face of each section/compartment of each MCC shall be 3/8-inch height.

E. The LVVFD SHALL NOT EXCEED the dimensions shown on the PLANS. Compartment/component arrangement shall be as shown on the elevation drawings shown on the PLANS. Provide for incoming feeder entering from below or above, and for outgoing circuits exiting from above and below.

2.03 MAIN CIRCUIT BREAKER

A. Provide thermal magnetic molded case circuit breakers with the following minimum requirements:
   1. U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than that of the bus serving the LVVFD. However, under no circumstances shall the RMS symmetrical short circuit current rating of the main circuit breaker be less than 42,000 amperes at 480 volts A.C.
   2. Circuit breaker shall be three pole, 600 volt with a maximum continuous current carrying capacity shown on the PLANS.
   3. Breakers shall operate continuously when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers.
   4. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Construction shall allow connection of supply conductors at either end. Breaker operating handle shall assume a center position when tripped.
   5. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
   6. Provide mechanical padlock attachment for each circuit breaker.
   7. Furnish lugs for feeders where required to facilitate field wiring termination, sizes shall be as required by the PLANS.

B. Provide where specifically shown on the PLANS:
   1. Current limiting circuit breaker

2. Electronic trip attachment. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings.
3. Auxiliary contacts rated for 120 volts A.C. Contacts shall satisfy the requirements of the PLANS. Pre-wire contacts to the control wiring terminal blocks located within the main breaker unit compartment.

2.04 VARIABLE FREQUENCY DRIVE CONTROLLER/STARTER UNITS

A. Each LVVFD starter/controller shall be a three-contactor bypass arrangement having the following characteristics:
   1. Each LVVFD assembly shall consist of a main circuit breaker, Main LVVFD Input, LVVFD Output Isolation, Full-Voltage Bypass Starter, and LVVFD Controller and power section as shown on the PLANS. The minimum output current of the LVVFD shall be as shown on the PLANS.
   2. Ratings shall be as shown on the PLANS, at minimum. Lesser ratings than as indicated on the PLANS will not be accepted.
   3. Main Circuit Breaker as previously specified. Provide a main circuit breaker for the VFD and full-voltage bypass starter assembly.
   4. Main Input, Main Output and Bypass Contactor/Starters with the following characteristics:
      a. Magnetic type, NEMA rated, with 120 volts A.C. operating coils. International type starters (IEC rated), will not be accepted, even if the starters were to show equivalent NEMA ratings
      b. Size and configuration (full voltage non-reversing, full voltage reversing, reduced voltage solid state, etc.) as shown on the PLANS
      c. Provide each starter coil with the manufacturer's standard transient voltage surge suppression module
      d. Provide auxiliary contacts as required by the PLANS. Contacts shall be rated for 120 volts A.C and shall satisfy the requirements of the PLANS. Provide each starter with one (1) normally open auxiliary contact wired to terminal blocks over the number of contacts required by the PLANS.
      e. The LVVFD Output Isolation and Full-Voltage Bypass contactors shall be mechanically interlocked to prevent operating at the same time.

B. Additional requirements for each LVVFD controller are as follows:
   1. Micro-processor based controller equipped with the manufacturer's standard features for protection, operation, and data acquisition of a LVVFD system. The operation of the controller shall also be coordinated with the operation of the motor protection and management relay specified hereinafter. Additionally, furnish the features as shown on the PLANS
   2. Electrically interlocked with the Main Input Contactor/Starter as well as the Main Output Contactor/Starter previously specified
   3. Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to variable voltage and frequency output. The manufacturer shall supply 6-Pulse bridge rectifier design, at minimum. The VFD shall have a 6 pulse integrally mounted phase shifting transformer.
   4. UL 508C tested
   5. Incomplete sequence protection of each LVVFD main input and output contactor shall be provided with interlocking circuitry to fault the LVVFD should the contactors fail to close when commanded
   6. Provide with ratings as follows:

Ambient Temperature Range:	0 to 40 degrees Celsius
Input Voltage:	480 ± 15 percent VAC
Input Voltage Frequency:	60 Hz ± 2 percent
Displacement Power Factor:	Not less than 0.975 lagging under any speed or load condition
Efficiency at full load:	95 percent or greater
Minimum Continuous Output Current:	As shown on the PLANS
Overtorque Capacity for Constant Torque Operation:	150 percent for 1 minute
Overtorque Capacity for Variable Torque Operation:	110 percent for 1 minute

7. The LVVFD section containing the VFD shall have a minimum of one (1) door mounted ventilation fan rated at 120VAC, thermostatically controlled, fused, and wired to the control power transformer, as also shown on the PLANS. Ventilation fan to provide positive forced air ventilation of LVVFD section containing the VFD. Provide dedicated thermostat for each LVVFD. Heat sinks shall not be allowed in the LVVFD structure. Furnish additional ventilation fans as required in accordance with LVVFD Manufacturer's recommendations to provide for proper VFD heat exchange.
8. The LVVFD section containing the VFD shall be supplied with a LVVFD door mounted air flow switch to detect positive air flow through the LVVFD section. Switch contacts to be rated for 5 ampere at 120 VAC, at minimum. Wire switch contacts as shown on the Drawings. The LVVFD section shall also be supplied with a temperature switch separate from the temperature switch required by subsection 2.05.C.5, this Section of the Specifications, to detect excessive LVVFD section temperature. Wire temperature switch as shown on the PLANS.
9. The control logic drawings in the PLANS show the minimum requirements for the LVVFD. Furnish additional controller contact inputs/outputs, interposing relays, selector switch contacts, fused power supplies, etc., as required to facilitate VFD operation

C. Provide Overload relays where required by the PLANS. Overload relays shall have the following characteristics:
   1. Standard class 20, ambient compensated
   2. Manually reset by push-button located on front of the compartment door
   3. Provide with auxiliary contact rated for 120 volts A.C. Contact shall satisfy the requirements of the PLANS
   4. The overload relay heaters will be selected by the CONTRACTOR after delivery of the LVVFD. Include all necessary delivery, packaging, and administrative costs associated with the delivery of overload heaters

D. Control Power Transformer. The transformer shall have the following characteristics:
   1. Adequately sized to serve all loads shown on the PLANS. Minimum size shall be as follows unless noted otherwise on the PLANS
      a. NEMA Size 4 and larger starters: 1000 VA

b. All other starters, 500VA
2. Primary side of the transformer shall be fused.
3. Connect as shown on the PLANS.

E. In each starter compartment, furnish and install one single pole fuse block with fuse for each motor space heater. Connect as shown on the PLANS.

F. A digital terminal keypad shall be provided with each starter/controller for viewing of electrical values, configuration of parameters, I/O assignments, application and activity function access, faults, local control, adjustment storage, self-test and diagnostics. The terminal keypad will consist of programmable function keys. The functions will allow both operating commands and programming options to be preset by the operator. The Keypad shall be rated NEMA Type 1 and be mounted to the face of the LVVFD.

G. Provide additional requirements as shown on the PLANS.

2.05 METERING AND POWER MONITORING UNIT "PMU"

A. Where required by the PLANS, furnish and install Power Metering Unit (PMU) in the LVVFD. The PMUs shall be as manufactured by General Electric - MULTILIN Model EPM 9700 (Transducer Module) with advanced software option complete with three line LED combination display and keypad Model P40NPLUS, with the Ethernet communication capability, harsh environment UL 746C/94 recognized conformal coating on all printed circuit assemblies and all required interconnect cabling as also shown on the PLANS, No Equal. Units shall be connected as shown on the PLANS.

B. Additional Requirements for the PMU:
1. Furnish and install an Ethernet connection to the PMU on the LVVFD door adjacent to the PMU LED display for accessing PMU settings files.
2. Where shown on the PLANS, furnish and install a patch panel in accordance with the requirements of Sub-Section 2.07 F, this Section of the Specifications.

2.06 INSTRUMENT TRANSFORMERS

A. General: All instrument transformers specified shall be installed and connected at the factory.

B. Instrument current transformers (C.T.s):
1. Provide current transformers where required by the PLANS. Connect as shown on the PLANS.
2. Current transformers shall be the window type and shall have an ANSI 60 Hz Metering Accuracy Class of 0.3 measured at burden of B0.1, at minimum.
3. Install a shorting terminal block for each current transformer (C.T.). Prewire all terminals of each C.T. to its respective shorting terminal block. Shorting terminal blocks shall be as manufactured by “G.E.”, or equal of the LVVFD manufacturer.

C. Instrument Potential Transformers (P.T.s):

1. Provide potential transformers where required by the PLANS. Connect as shown on the PLANS.
2. Potential transformers shall have the following characteristics:
   a. Primary voltage: 480 volts A.C.
   b. Secondary voltage: 120 volts A.C.
   c. Accuracy rating: 0.6 Y at burden of 1.2X
   d. Thermal Burden: 150 VA at 30 degrees C ambient
   e. Frequency: 60 Hz.
3. Install with primary and secondary disconnect devices, grounding device, and accessories in conformance with IEEE and NEMA standards.
4. Provide current limiting type primary fuses.

2.07 MISCELLANEOUS ACCESSORIES

A. Control relays shall have the following characteristics:
   1. 600 volts, standard NEMA Size, AC Heavy-Duty industrial type with 120 volt AC coils
   2. Minimum contact rating of 10A, continuous, at 120 volts AC.
   3. Furnish each relay with one additional Normally Open (N.O.) and one additional Normally Closed (N.C.) contacts over the number required by the PLANS. Relays shall have field configurable type contacts
   4. Provide each relay with Relay Manufacturer's Transient Suppression Module.
   5. Relays shall be "Allen Bradley Bulletin 700", Type-700P, or equal relays of the LVVFD manufacturer.

B. Timing Relays shall have the following characteristics:
   1. Solid state, multi-time, and multi-function type relay
   2. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes:
      a. On Delay
      b. Off Delay
      c. One Shot
      d. Repeat Cycle
      e. Interval
   3. Minimum relay contact rating shall be 10 amps, continuous, at 120 VAC.
   4. Timing relays shall be Square D Class 9050 model No. JCK70 complete with Type NR61 Socket, or equal timing relays of the LVVFD manufacturer

C. Pushbuttons, Selector Switches, and Pilot Lights:
   1. General Requirements:
      a. Rating: NEMA 4X, corrosion resistant, Heavy Duty
      b. Size: NEMA Style full size 30-millimeter (30mm)
      c. Contacts: 10 ampere minimum at 120 volts A.C. Provide number of contacts to satisfy the requirements of the PLANS
      d. Legend Plate: Provide per manufacturer's standard with inscription as shown on the PLANS
      e. Manufacturer: Allen Bradley Bulletin 800H, or Square D Class 9001 Type K
   2. Additional Requirements for Selector Switch/ Pushbuttons:
      a. Operator Color: Black, unless shown otherwise on the PLANS

b. Selector Switch Action Type: Maintained action, unless shown otherwise on the PLANS
c. Pushbutton Action Type: Momentary action, unless shown otherwise on the PLANS

3. Additional Requirements for Pilot Lights:
   a. Type: Transformer Type Light Emitting Diode (LED)
   b. Voltage: 120 volts A.C.
   c. Style: Push-to-test
   d. Lens Color: Provide the colors shown on the PLANS

D. Potentiometer: Variable Resistance (potentiometer) shall be a single turn potentiometer as required by the PLANS. Each Potentiometer shall have a resistance per the requirements of the LVVFD manufacturer. The color of the Potentiometer operators shall be BLACK unless otherwise noted on the PLANS. Rated NEMA 4X. Provide with legend plate with the inscription shown on the PLANS. The Manual Speed Potentiometer shall be as manufactured by ETI Systems, Model SP22E-SB-5K SEALED BODY POTENTIOMETER, no equal.

E. Elapsed Time Meters shall be the non-resettable type, and shall have cyclometric type reading at least to 9999.9 hours and at least to the nearest one-tenth of an hour. Elapsed time meters shall be as manufactured by Eagle Signal/Danaher controls series HK410, or approved equal. Mount to the front of the MCC.

F. Ethernet Patch Panel: Where Ethernet patch panel shown on the PLANS, furnish and install a dedicated patch panel for termination of the Ethernet data highway (serial communication) cabling for each LVVFD and Power Monitoring Unit. Patch panels shall be two-port, surface mounted, fully enclosed type, Category 6A, with RJ-45 connectors, as manufactured by “Panduit”, Model Mini-Com #CBXQ2AW-A, with “Mini-Com TX6A” UTP Coupler Module Model CJ6X88TGBU and blank cover plates, or equal by Siemon, Hubbell, or CommScope. Ethernet patch cords shall be furnished and installed between the patch panel and the respective LVVFD and/or PMU per the requirements of Section 17600 “Distributed Control System”.

G. Fiber Optic Patch Panel: Where fiber optic patch panel shown on the PLANS, furnish and install a dedicated patch panel for termination of the fiber optic communication cabling for each LVVFD and Protective Relay. Patch panels shall be as specified in Section 17600 “Distributed Control System” Subsection

H. Communication Device: The LVVFD assembly shall consist of an integral communication device to allow remote monitoring and control of the LVVFD unit. The communication device shall, at minimum, telemeter LVVFD “ON” and “OFF” status, fault condition, cause of fault condition, LVVFD frequency, phase current, line to line voltage, power and energy consumption, and alarm conditions. The communication device shall communicate with the owner’s communication equipment over the communication protocol Modbus-TCP Ethernet. The communication device shall be as manufactured by the LVVFD manufacturer and integral to the LVVFD assembly and within the LVVFD enclosure. If the LVVFD manufacturer’s communication device does not consist of a MODBUS-TCP protocol option, the manufacturer may furnish and install a protocol conversion bridge device, within the LVVFD enclosure, to convert from the communication device

protocol to the MODBUS-TCP protocol. LVVFD manufacturer shall coordinate with Owner and ICS contractor for setting of the LVVFD communication device.

I. Long-Lead dV/dt Filter: Where long-lead filter shown on the PLANS, furnish and install long-lead dV/dt type filter inside the LVVFD enclosure. Long-lead filter shall be of the LVVFD manufacturer, or equal by Hammond Power Solutions.

J. Provide key interlocks where required by the PLANS

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TEST

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01782 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Install per manufacturer's instructions and recommendations. Install all required safety labels.

B. Perform manufacturer's field services as previously specified

C. Size, furnish and install the overload relay heaters based on actual motor nameplate current. Set overload relay settings at maximum values permitted by the NEC 430-32

D. Size, furnish and install the motor space heater fuses based on actual motor space heater load current

3.03 FIELD TEST AND CHECKS

A. Verify proper rotation of all motor loads.

B. Verify motor space heater circuits are operational.

C. The following minimum test and checks shall be made before energizing the LVVFDs. These tests shall be performed by a Factory Trained Field Technician (non sales type):
   1. Thoroughly inspect the LVVFDs
   2. Test for proper phasing of power connections. Additionally, check phasing across the LVVFDs using phasing sticks.
   3. Set, adjust, and test all protective relays based on the results of the coordination study, refer to sub-section 1.08, this Section of the Specifications.
   4. Megger terminals and buses for grounds, test per manufacturer's recommendations.
   5. Verify ratios of all CT's, and proper operation of all metering.

6. Verify LVVFD enclosure space heater circuits are operational.
7. Test key interlock system functionality
8. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

D. Submit documentation of all tests outlined above. Include all test documentation data in operation and maintenance manuals.

E. Submit manufacturer's certification report per sub-section 1.08, this Section of the Specifications. Include certification report in operation and maintenance manuals.

3.04 EQUIPMENT PROTECTION AND RESTORATION

A. Clean and vacuum clean all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

C. Energize the space heaters within the LVVFD and energize during storage and installation for humidity control.

3.05 TRAINING

A. Provide training sessions for OWNER's representatives for Two (2) FULL normal workdays at the job-site location and/or at a location determined by the owner. If training is conducted in less than the time required by these specifications, the remaining time shall be utilized at the discretion of the Owner.

B. The training session shall be conducted by the LVVFD manufacturer's non-sales-type technical representative, who performed the field installation and start-up/setting/adjustment services.

C. At minimum, the training session shall include:
1. Operation and maintenance procedure for the equipment and all components installed within the LVVFDs.
2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.
3. Potential of arc-flash hazards associated with working on energized equipment.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 16500

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install panelboards and surge protective devices where indicated on the PLANS and as specified herein.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work

C. The PLANS designate the type, size, ratings, and other requirements of the equipment specified in this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Specifications. For each individual Panelboard include:
   1. Panelboard dimensions
   2. Ratings
   3. Branch circuit breaker schedules
   4. Main circuit breakers size
   5. Protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves
   6. Transformer impedance, where applicable

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. Include:
   1. Copies of the approved shop drawings
   2. On-site/field test data.

1.04 QUALITY ASSURANCE

A. Panelboards to be U.L. labeled "U.L. 67", "U.L 508" and meeting Fed. Spec. WP-115, Type 1, Class 1, latest revisions. Breakers to meet Fed. Spec. WC-375, latest revision.

1.05 DELIVERY, STORAGE, HANDLING, AND TOOLS

A. Deliver, receive, unload and handle equipment by suitable methods. Store in climate controlled (temperature and humidity, etc.) environment in original packaging, or, in protective plastic wrapping.

B. Provide breaker test set for Solid-State-Trip units for each type used.

1.06 ACCEPTABLE MANUFACTURERS

A. All Panelboards on the project shall be manufactured by a single Panelboard manufacturer.

B. 480 volts A.C., 3-phase, 3-wire Power Distribution Class Panelboards:
   1. Square D Company Series I-LINE with specified accessories. Approved equal Panelboards manufactured by Eaton Cutler-Hammer or Asea Brown Boveri are acceptable as equals.

C. 208/120 volts A.C., 3-phase, 4-wire Panelboards:
   1. Eaton Cutler-Hammer Corporation Type POW-R-Line 3a with specified accessories. Approved equal Panelboards manufactured by Square-D Company or Asea Brown Boveri are acceptable as equals.

D. 208/120 volts A.C., 3-phase, 4-wire Mini-power Center Transformer/Panelboard:
   1. Square D Type Mini-power Zone with specified accessories. Approved equal Panelboards manufactured by Eaton Cutler-Hammer or Asea Brown Boveri are acceptable as equals.

E. 208/120 volts AC, 3-phase, 4-wire Distribution Class Panelboard with Integral Contactors (combination Contactor and distribution panelboard assembly) – Cutler-Hammer Corporation Type 4B with specified accessories. Approved equal Panelboards manufactured by Square-D Company or Asea Brown Boveri are acceptable as equals. Note: installation of ASCO-911 (or approved equal) Contactor inside combination distribution panelboard and contactor assembly will be acceptable.

1.07 SPECIAL MANUFACTURER'S SERVICES

A. Prepare an arc-flash study, harmonic study, and a coordination study, complete with short circuit calculations and coordination curves, etc. as required by and in compliance with Section 16140 of the Specifications "Switchboards", paragraph 1.08 "Special Manufacturer's Services".

B. Manufacturer's technical representative is to set, adjust and test all protective relays, etc. in the presence of a representative of the Owner. The settings will be based on coordination and short circuit studies performed per subsection 1.10.A, this Section of the Specifications. Provide the Owner with test report certified by the manufacturer. Include a record of all settings. Format and quantity of reports shall be per the requirements of Section 01300 of the Specifications. The Manufacturer shall furnish the protective device of the appropriate characteristics that shall be the

most suitable for the proper protection and coordination of the system at No Additional Cost to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

A. Bussing Requirements:
   1. Main Bus:
      a. All buses shall be tin-plated copper, distributed phase sequence type, and shall extend the full length of the panelboard.
      b. Refer to the PLANS for bus ratings. Ratings to be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50 degrees Celsius rise above an ambient of 40 degrees Celsius.
      c. Circuit numbering to be such that odd numbered circuits are on the left and even numbered on the right facing the front of the panel.
   2. Ground Bus:
      a. Each panelboard shall have a tin plated copper ground bus for connecting equipment grounds. Ground bus shall not be connected to the neutral bus.
   3. Isolated Ground Bus:
      a. In all 208/120 volts A.C., 3-phase, 4-wire Panelboards served from shielded ultra-isolation transformers, furnish a second tin-plated isolated ground bar in addition to the equipment ground bar. The isolated ground bar shall be electrically isolated from the panelboard cabinet/enclosure by 600 volt isolators. Isolated ground bar shall have the same current rating as the phase-bussing (bus rating) of the panelboard.

B. Circuit Breakers:
   1. General:
      a. Circuit breakers to be single pole, two pole or three pole as shown on the PLANS.
      b. All breakers to be quick-make, quick-break thermal magnetic molded case bolt-on type, with inverse time thermal trip and instantaneous time magnetic trip. Multi-pole breakers to be common trip with a single trip handle. Provide overload tripping elements in each pole. A tripped condition to be indicated by the breaker assuming a neutral position between “ON” and “OFF”.
      c. Circuit breakers to be equipped with individually insulated, braced and protected connectors. Affix large, permanent, individual circuit numbers to each breaker in a uniform position.
      d. Circuit breakers for lighting circuit protection are not to be larger than 20 amperes.
      e. Key interlocks shall be provided for circuit breakers where shown on the PLANS.
      f. Padlock attachments shall be provided for circuit breakers where shown on the PLANS.
      g. Provide lugs as required to facilitate the field wiring termination shown on the PLANS.

2. Circuit breaker interrupting ratings and type to be as follows:
    a. Main/Branch Circuit Breakers in Power Distribution Panelboards and Main Circuit Breakers in Lighting/Control Power Panelboards and Main/Branch Circuit Breakers in Mini-power Centers:
        1) Minimum U.L listed Symmetrical Current Interrupting rating (A.I.C. rating) at rated voltage shall be as shown and required by the PLANS.
        2) Panelboards shall be provided with high interrupting capacity or current limiter type breakers where necessary to withstand the available short circuit or limit it to a value which the downstream breakers can withstand.
        3) Provide current limiting circuit breakers where shown on the PLANS.
        4) Provide electronic trip attachment were shown on the PLANS. Trip unit shall be solid state type with field adjustable long time, short time, ground fault and pick up settings.
        5) Provide as manufactured by Square D Company Type FC, or approved equal by Asea Brown Boveri, Eaton Cutler-Hammer Corporation.
    b. Branch Circuit Breakers in Lighting/Control Power Panelboards:
        1) U.L listed Symmetrical Current Interrupting 10,000 A.I.C. symmetrical at rated voltage.
        2) Provide as manufactured by Square D Company Type QOB, or approved equal by Asea Brown Boveri, Eaton Cutler-Hammer Corporation.
    c. Branch Circuit Breakers in Lighting/Control Power Panelboards:
        1) U.L listed Symmetrical Current Interrupting 10,000 A.I.C. symmetrical at rated voltage.
        2) Provide as manufactured by Square D Company Type QOB, or approved equal by Asea Brown Boveri, Cutler-Hammer Corporation.
    d. Branch Circuit Breakers in Mini-power Centers:
        1) U.L listed Symmetrical Current Interrupting 10,000 A.I.C. symmetrical at rated voltage.
        2) Although required otherwise elsewhere, bolt-on type circuit breakers are not required for these assemblies.
        3) Provide as manufactured by Square D Company Type QO, or approved equal by Asea Brown Boveri, Eaton Cutler-Hammer Corporation.

C. Miscellaneous Requirements:
    1. Integrated Equipment Rating: Each panelboard, as a complete unit, shall have a rating equal to or greater than the integrated equipment rating shown on the PLANS.
    2. Provide a minimum of 20 percent spares on all panelboards and/or as shown on panel schedules on the PLANS.

2.02 MINI-POWER CENTER TRANSFORMER

A. General:
    1. All windings shall be copper.
    2. Transformer shall be totally encapsulated in epoxy resin.

3. Furnish with two (2) 5 percent full capacity primary taps below rated primary voltage.
4. 115 degrees Celsius temperature rise above 40 degrees Celsius ambient.
5. All insulating materials shall be in accordance with NEMA ST20 standards for a 175 degree Celsius U.L. component recognized insulation system.

B. Enclosure: NEMA-4X, Type 316 stainless steel

2.03 COMBINATION CONTACTOR AND DISTRIBUTION PANEL

A. General:
1. Comply with the requirements of subsection 2.01, this Section of the Specifications. Circuit breakers shall be furnished and installed per the requirements for Type I panelboards.
2. Panelboard shall have a contactor mounted integral to the panelboard.

B. Contactor Section of the Panelboard:
1. Voltage: 208/120 Volts A.C.
2. Current: 100 ampere at minimum, unless shown otherwise on the PLANS. Regardless, rating shall not be less than the panelboard main bus.
3. Type: Totally enclosed, four pole, mechanically held, single throw normally open contacts. 100 percent rated for bulk load control of all types of ballast and tungsten lighting, motor loads, resistant loads, and transformer loads.
4. Integrated interrupting rating: 10,000 ampere at 208 Volts A.C., unless shown otherwise on the PLANS. Rating shall apply to the entire combination contactor/ panelboard assembly as a complete unit.
5. Controls:
   a. Coil Voltage: 120 Volts A.C.
   b. Auxiliary Contacts: Furnish and install contacts as required to meet the requirements of the PLANS. Furnish and install one normally open (N.O.) and one normally closed (N.C.) contact over and above that required by the PLANS.
   c. Furnish and install terminal blocks for connections to interlock field control wiring per manufacturer's standard.
   d. Furnish with heavy duty, NEMA Style, full size 30-millimeter selector switch with legend plate where selector switches are shown on the PLANS.
   e. Refer to the PLANS for control wiring requirements.

2.04 CABINET

A. Adhere to the requirements of UL 50.

B. Panelboard assemblies installed INDOORS:
1. Enclosure: NEMA-12, gasketed
2. Doors: Provide door-in-door type arrangement
3. Finish: Primed and painted using the manufacturer's standard finishing process. Finish shall be applied at the manufacturing plant. Color shall be ANSI #61 Gray finish

C. Panelboard assemblies installed OUTDOORS:
   1. Enclosure: NEMA-4X, 316 Stainless Steel
   2. Doors: Provide door-in-door type arrangement

D. A circuit directory in a metal frame with clear plastic covering shall be provided on the inside of the door. A directory card shall be typed to identify the load served by each circuit. Spare breakers shall be noted in pencil, however.

E. The panelboard interior assembly to be dead front with panelboard front removed. Main lugs or main breaker to be barrier on five sides. The end of the bus structure opposite the mains to be barriered.

2.05 NAMEPLATES

A. General:
   1. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
   2. Color: White-Black-White
   3. Lettering: 1/2 inch height, minimum, engraved through the face layer to the melamine middle layer.
   4. Accessories: Provide holes for mechanical fastening.

2.06 SURGE PROTECTIVE DEVICE

A. Furnish and install Surge Protective Devices (SPD) where required by the PLANS. Each SPD shall have the following features:
   1. Number of phases and system configuration (delta, wye grounded) to match and fully protect the bus to which the SPD is connected.
   2. SPD shall be tested with the ANSI/IEEE Category C high exposure waveform of 10 kA for 8 x 20 microseconds, at minimum.
   3. Visual indication of SPD status
   4. Surge counter
   5. Provide dry contact failure status output contact. Contact shall be rated for 120 volts A.C. and shall satisfy the requirements of the PLANS.
   6. UL 1449
   7. 10 year minimum warranty
   8. SPD surge current withstand ratings shall be as follows:

Panelboard Voltage	Minimum Current Withstand Rating (Ampere per Phase)	Minimum Current Withstand Rating (Ampere per Mode)
480 volts AC	160kA	80kA
120/208 volts AC	80kA	40kA

B. Enclosure:
   1. SPD located indoors in environmentally controlled rooms: NEMA 12
   2. SPD located outdoors or indoors in non-environmentally controlled rooms: NEMA 4X, Type 316 stainless steel. Enclosures shall have a smooth, non-brushed finish.

C. Manufacturer: Innovative Technologies Model PTX 120, Surge Suppression Inc. or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panelboards at the locations shown on the PLANS per the manufacturer's instructions and recommendations.

B. Top of all panelboards shall be at no higher than 6 foot 0 inches above the finished floor elevation, unless specifically noted otherwise on the PLANS.

C. Tagging:
   1. Tag equipment with the name as it appears on the PLANS using the specified nameplates. Panelboard nameplate shall also include: voltage ratings, phase, wire, ampere rating, AIC and withstand current rating, size and type of the main circuit breaker OR Main Lug Assembly (as applicable).
   2. Panelboards shall be provided with typed circuit schedule including circuit number, breaker rating and circuit description.

D. Balance phases as closely as possible and type in directory at the close of the job. Use erasable pencil to indicate "Spares" and "Spaces".

E. For surface mounting, use support channel per the requirements of Section 16150 "Raceways, Fittings and Supports" and per the details shown on the PLANS. For floor mounting, provide equipment pad as shown on the PLANS. Also refer to the details shown on the PLANS.

F. Connect SPD per the requirements of the PLANS and in accordance with the SPD manufacturer's recommendations.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

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SECTION 16524

480 VOLT AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install the 480 Volt Automatic Transfer Switch (ATS) as specified herein and as shown on the PLANS.

B. Where specifically shown on the PLANS, furnish and install the Automatic Transfer and Bypass Isolation Switch as specified herein and as shown on the PLANS. The Automatic Transfer and Bypass Isolation Switch shall consists of two major elements that are furnished and installed pre-wired, factory interconnected, and mounted inside a single common enclosure as an assembly:
   1. The automatic transfer switch (ATS) as specified hereinafter,
   2. The bypass-isolation switch, hereinafter specified by Subsection 2.7, this Section of the Specifications

C. All other requirements of each ATS described hereinafter shall also apply to each Automatic Transfer and Bypass Isolation Switch.

1.02 RELATED WORK NOT INCLUDED

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the size, rating, and other requirements of the equipment specified under this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 QUALIFICATIONS

A. The ATS shall be designed, constructed, and tested in accordance with the latest applicable requirements of NEMA, ANSI, U.L., and NEC standards.

B. All ATS's on the project shall be manufactured by a single ATS manufacturer.

C. The ATS shall be as manufactured by "Automatic Switch Company-ASCO, Model 7000" or Russelectric Inc, No Equal.

1.04 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Specifications. Submittals shall include:
   1. Dimensioned/scaled top and bottom views, front elevations, and internal component/device layouts
   2. One-line and wiring diagrams,
   3. Catalog cut sheets

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. O&M Manuals shall include copies of the approved shop drawings. Also, as minimum the Operations and Maintenance Manuals shall include:
   1. Copies of certified and approved shop drawings.
   2. Detailed information on each component used, including:
      a. Installation and operation manual.
      b. Renewal parts bulletin.
      c. As built drawings, including approved shop drawings.
      d. Test data.
      e. Detailed transfer switch setting parameters, DIP-switch settings, ranges, options, operating setting and calibrating instructions, etc.

1.05 STORAGE AND HANDLING

A. Protection
   1. The CONTRACTOR, and hence the ATS supplier, shall be responsible for safety of the ATS during storage, transporting and handling.
   2. The ATS shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment.
   3. At all times the ATS shall be housed inside a moisture free, non-porous, extra heavy duty plastic weatherproof housing.
   4. Interior and exterior of the ATS shall be kept clean at all times.
   5. Size, furnish and install temporary space heaters within the ATS and energize during storage and installation for humidity control.

B. Additional project job site storage requirements: Upon delivery to the project site and prior to final installation, protect and store in accordance with the following:
   1. Environmentally protected and stored in climate controlled (temperature and humidity) environment at the job site. Size, furnish and install temporary air conditioners and additional environmental control equipment complete with branch circuiting conduit/wire as required to maintain in a controlled environment at the following conditions:
      a. Ambient Dry Bulb Temperature:
         1) Minimum: 68 degrees Fahrenheit.
         2) Maximum: 85 degrees Fahrenheit.
      b. Ambient Relative Humidity: Maximum: 50%
   2. Every effort shall be made to provide all necessary electrical power connections ready for immediate connection to equipment upon arrival of equipment on jobsite.
   3. Upon arrival of equipment onto job site, the Contractor shall provide proper transition of power to equipment, especially any 120 VAC powered equipment,

to ensure all air conditioning and heating equipment are fully operational and that the equipment is in a conditioned space on the day the equipment arrives.

4. Furnish and install replacement air filters, etc., as required for proper operation of the environmental control equipment.

1.06 SPARE PARTS

A. One (1) quart of touch up paint.

PART 2 PRODUCT

2.01 AUTOMATIC TRANSFER SWITCHES (ATS) REQUIREMENTS AND UNIT DESCRIPTION

A. General:
   1. ATS shall be completely factory interconnected, pre-wired and tested.
   2. ATS mechanism shall be of the electrically operated, double throw mechanically held type, actuated by a single solenoid operator momentarily energized to assure quiet operation.
   3. ATS shall be inherently interlocked, mechanically in either normal or emergency position with no “OFF” position possible. Gravity or spring operated switches will not be acceptable. ATS shall be the “open transition” type of automatic transfer switch.
   4. All main contacts shall be provided with silver alloy material for high conductivity under all conditions of service. The ATS shall be suitable for all classes of loads, including inductive loads, resistive loads, control loads, and electrical discharge and tungsten-filament loads.
   5. Inspection of contacts shall be possible from the front of the switch.
   6. A manual operating handle shall be provided.
   7. The ATS shall have a U.L. listed minimum RMS symmetrical short circuit current rating equal to or greater than the minimum RMS symmetrical short circuit current rating shown on the PLANS. The ATS contacts rating and number of poles shall be as shown on the PLANS (electrical one line diagrams).
   8. The ATS shall be furnished complete with the automatic transfer control system.
   9. The ATS, automatic control transfer system, sensors, timers, etc. shall be mounted, as one unit, in a single enclosure as specified hereinafter. The ATS shall be mounted where shown on the PLANS.

2.02 ADDITIONAL REQUIREMENTS FOR THE AUTOMATIC TRANSFER AND BYPASS-ISOLATION SWITCH

A. Furnish and install the automatic transfer and bypass-isolation switch where specifically required by the PLANS. The following are additional requirements for each Automatic Transfer and Bypass-Isolation Switch over and above the requirements for each ATS:
   1. The bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and

load power conductors without interrupting power to the load. All main contacts shall be manually driven.

2. Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions.
3. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." In the “Bypass to Normal” mode, the “normal” source serves the load. In the "Automatic" mode, the ATS control system selects the source to serve the load. Additionally, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected. In the “Bypass to Emergency” mode, the “emergency” source serves the load.
4. The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The “Closed” mode shall permit the normal operation of the ATS. The "Test" mode shall permit testing of the ATS with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance without the removal of power conductors.
5. When the isolation handle is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch and shall allow manual transfer of load to either power source (normal or emergency) regardless of the position (normal or emergency source selection) of the ATS or if the ATS is drawn-out.

2.03 AUTOMATIC TRANSFER SWITCH (ATS) CONTROL REQUIREMENTS

A. General:
   1. The ATS shall automatically transfer power from one power source to another, in the event of normal/primary power source failure, one primary feeder failure, etc. The ATS shall ensure continuity of the load circuit power supply for as long as one of the two primary feeders to the ATS is active. The ATS shall also include functionality to initiate transfer of power from one source to another based upon discrete commands received from the Owner’s Distributed Control System, as also shown on the PLANS.

B. Voltage and frequency sensing:
   1. Provide field adjustable setpoints with the following Dropout and Pickup ranges for the following parameters:

Parameter	Source	Dropout	Pickup Range
Undervoltage	Normal and	70% – 98%	85% - 100%
Underfrequency	Normal and	85% - 98%	90% - 100%
Voltage	Normal and	5% - 20%	2% below

C. Transfer time delays:
   1. Provide the following field adjustable setpoints with the following ranges:
      a. Time delay to override momentary normal power source outages to delay transfer switch: 0 to 6 seconds.
      b. Transfer to backup power source time delay: 1 to 300 seconds.
      c. Time delay to re-transfer to normal power source (upon restoration): 0 to 30 minutes.

D. Manual transfer switch controls:
   1. Combination Display and Keypad: Provide manufacturer's standard four line, 20 character liquid crystal display (LCD) combination display and pushbutton keypad user interface module. The combination display and keypad module shall be an integral part of the ATS for viewing all available data and field adjustment of desired operational parameters. Mount the Combination Display and Keypad to the face of the ATS.

E. Accessories:
   1. Provide a detailed instruction plate for convenient operation.
   2. Auxiliary Contacts:
      a. All contacts shall be rated for 10 ampere at 120 volts A.C. Wire to terminal blocks.
      b. Provide contacts for the following:
         1) ATS in normal position.
         2) ATS in emergency (backup) position.
         3) Normal source voltage is present.
         4) Emergency (backup) source voltage is present.
         5) Additional contacts where required by the PLANS.
   3. Nameplates:
      a. Provide nameplates/legend plates for each pilot device and each component/device/equipment installed on the face and inside the enclosure of the ATS.
      b. Identification Nameplates:
         1) Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
         2) Color: White-Black-White.
         3) Lettering: Nameplate shall be legible at a distance of six feet from the nameplate. Lettering shall be engraved through the face layer to the melamine middle layer.
         4) Accessories: Provide holes for mechanical fastening
         5) Nameplates located on the face of the cabinet shall be secured with two Stainless Steel screws.

2.04 AUTOMATIC TRANSFER SWITCH (ATS) ENCLOSURE

A. The ATS assembly (controls, contactors, sensors, relays, etc.) shall be mounted in a NEMA-12 gasketed enclosure. The ATS controller combination display and keypad and switch operators shall be mounted on the face of the enclosure door. Each door shall have a continuous piano hinge with key-lockable stainless steel handle (3-point latching mechanism).

PART 3 EXECUTION

3.01 FACTORY INSPECTION AND TESTS

A. Standard factory tests shall be performed on the equipment specified in this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards. The manufacturer shall provide certified copies of factory test reports prior to shipment of the equipment to the project site. Format and quantities of the test report shall be in accordance to Section 01300 and Section 01730 of the Contract Specifications.

3.02 FIELD INSTALLATION (BY CONTRACTOR)

A. Mount the ATS as shown on the PLANS. Top of ATS shall be no higher than 6 foot 0 inches above the finished floor elevation. For surface mounting, use support channel per the requirements of Section 16150 “Raceways, Fittings and Supports” and per the details shown on the PLANS. For floor mounting, provide equipment pad as shown on the PLANS. Also refer to the details shown on the PLANS.

3.03 FIELD TEST AND CHECKS

A. The following minimum test and checks shall be made before energizing the ATS. These tests shall be performed by a Factory Trained Field Technician (non sales type):
   1. Thoroughly inspect ATS.
   2. Test for proper operation.
   3. Calibrate, set and test control timers, relays according to settings provided and required by this Specifications Section and as recommended by the manufacturer.
   4. Submit documentation of all tests outlined above. Include all test documentation data in operation and maintenance manuals.

3.04 EQUIPMENT PROTECTION AND RESTORATION (BY CONTRACTOR)

A. Clean and vacuum clean all interior of the equipment.

B. Touch-up and restore damaged surfaces to factory finish.

3.05 TRAINING

A. Provide training sessions for OWNER’s representatives for Two (2) normal workday and Four (4) working hours each day, at the job-site location. If training is conducted in less than the time required by these Specifications, the remaining time shall be utilized at the discretion of the OWNER.

B. The training session shall be conducted by the ATS manufacturer’s non-sales-type technical representative.

C. At minimum, the training session shall include:
   1. Operation and maintenance procedure for the equipment and all components installed within the ATS.

2. Factory contact persons phone numbers, persons names, ordering procedures and procedures to follow to obtain meaningful results from the factory.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 16540

FIELD CONTROL STATIONS

PART 1 GENERAL

1.01 SCOPE

A. Furnish and install field control stations as specified herein and as shown on the PLANS.

1.02 RELATED WORK NOT INCLUDED

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings, product data, and layout drawings for the products of this Section in accordance with Section 01300 of the Specifications.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. O&M Manuals shall include copies of the approved shop drawings.

PART 2 PRODUCTS

2.01 PUSHBUTTONS, SELECTOR SWITCHES, PILOT LIGHTS

A. General Requirements:
   1. Rating: NEMA 4X/13, heavy duty, oil tight/corrosion resistant, hermetically sealed and rated for use in wet locations and in Class I Division 2 hazardous areas (as classified by NEC).
   2. Size: NEMA Style full size 30-millimeter (30mm),
   3. Contacts: 5 ampere minimum at 120 volts A.C. Hermetically sealed and stackable contact blocks. Provide number of contacts to satisfy the requirements of the PLANS.
   4. Legend Plate: Provide per manufacturer's standard with inscription as shown on the PLANS.
   5. Manufacturer: Allen Bradley Bulletin 800R, or approved equal.

B. Additional Requirements for Selector Switch/ Pushbuttons:
   1. Operator Color: Black, unless shown otherwise on the PLANS.
   2. Selector Switch Action Type: Maintained action, unless shown otherwise on the PLANS.
   3. Pushbutton Action Type: Momentary action, unless shown otherwise on the PLANS.
   4. Furnish one Normally Open and one Normally Closed contact block over the quantity shown on the PLANS for each selector switch and pushbutton.

C. Additional Requirements for Pilot Lights:
   1. Type: Transformer Type Light Emitting Diode (LED),
   2. Voltage: 120 volts A.C.
   3. Style: Push-to-test
   4. Lens Color: Provide the colors as shown on the PLANS:

D. Additional requirements for Emergency Stop/Trip Push-Button Stations:
   1. Action Type: Push-Pull maintained
   2. Operator Type: Mushroom head
   3. Operator Color: Red, unless shown otherwise on the PLANS
   4. Each button shall be provided with a hinged polycarbonate corrosion resistant locking cover. Cover shall be capable of closing without actuating the push button. Cover shall be C3 Controls Model LOAFC, or approved equal.
   5. Padlock: Furnish and install padlock with 0.25 inch diameter padlock shackle. Coordinate the shackle diameter with the padlock attachment. Furnish and install padlock as manufactured by Master Lock, or approved equal.

2.02 MANUAL SPEED POTENTIOMETERS

A. Furnish and install where required by the PLANS. Additional manual speed potentiometer features are as follows:
   1. Each potentiometer shall have a resistance per the requirements of the variable speed controller manufacturer.
   2. Potentiometer Action Type: Single turn variable resistance potentiometer.
   3. Operator Color: Black, unless shown otherwise on the PLANS.
   4. Manufacturer: ETI Systems, Model SP22E-SB-5K SEALED BODY POTENTIOMETER.

2.03 FLASHING LIGHT BEACON

A. Type: Heavy duty, LED, flashing beacon.

B. Lens: Red polycarbonate

C. Power: 120 volts A.C.

D. Enclosure: NEMA-4X rated, glass reinforced thermoplastic polyester resin

E. Operating temperature range: -31°F to 150°F (-35°C to 66°C)

F. Mounting: Refer to the PLANS
   1. Pipe mount attachment catalog no. 105BM

2. Outlet box attachment catalog no. 105BX
    a. with mounting bracket catalog no. 105BM, where applicable.

G. Certifications: U.L. Listed for Marine Applications, Class I Division 2

H. Manufacturer: Edwards 105XBRMR120A with specified mounting accessories, or Engineer approved equal.

2.04 VIBRATING TYPE AUDIBLE HORNS

A. Furnish and install where required by the PLANS. Additional vibrating type audible horn features are as follows:
1. Type: Heavy duty vibrating type audible horn
2. Output Level: 97 dB at 10 feet
3. Power:
    a. 120 volts A.C.
    b. Power connection wires embedded in sealing compound
4. Enclosure:
    a. NEMA-4X rated, gasketed die-cast box with heat flowed epoxy corrosion resistant finish.
    b. Mounting brackets on either side for wall mounting.
    c. 3/4-inch NPT conduit hub on one side.
5. Certifications: U. L. Listed and designed for use in Class I, II and III, Division 1 and 2 hazardous locations.
6. Manufacturer: Edwards Signaling 878EX-N5, or Engineer approved equal.

2.05 FIELD CONTROL STATION ENCLOSURE

A. Size: As required

B. Rating: NEMA-4X

C. Material: Type 316 Stainless Steel.

D. Doors and door latches: Boxes shall be equipped with hinged doors complete with 1/4 (quarter) turn door latches.

E. Manufacturer: Allen-Bradley, Hoffman, Rittal, Millbank, or approved equal.

2.06 LEGEND PLATES/NAMEPLATES FOR CONTROL STATIONS

A. General:
1. Provide nameplates/legend plates for each control station, and each pilot device installed in a control station as shown on the PLANS and as previously specified.

B. Identification Nameplates:
1. General: Furnish and install identification nameplates for each field control station as follows unless shown otherwise on the PLANS:
    a. Type: 3-ply, 1/8” thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall

be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.

b. Color: White-Black-White
c. Lettering: 1/4-inch height minimum unless shown otherwise on the PLANS, engraved through the face layer to the melamine middle layer.
d. Accessories: Provide holes for mechanical fastening
e. Attachment Means: Secured with two Stainless Steel screws.

PART 3 EXECUTION

3.01 INSTALLATION

A. Minimum mounting height shall be 3-foot 6-inches above finished floor unless shown otherwise on the PLANS. Secure stations firmly to support channels as specified in Section 16150 “Raceways, Fittings and Supports”.

3.02 FIELD TESTING

A. Perform field testing as required elsewhere.

3.03 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 16550

GROUNDING

PART 1 GENERAL

1.01 SUMMARY

A. Provide grounding in accordance with the PLANS, these Specifications and the National Electrical Code "N.E.C." Included within this section are furnishing and installing all the wire, connections, and other devices associated with the grounding system associated with the aforementioned.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit shop drawings on all grounding system product and in accordance with Section 01300 of the Specifications. Include material safety data sheet for ground enhancement material.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Specifications. O&M Manuals shall include copies of the approved shop drawings, and on-site/field test data.

PART 2 PRODUCTS

2.01 GENERAL

A. Ground electrodes shall be 3/4-inch diameter by 10'-0" long (as shown on the PLANS), copper clad steel ground rods by Erico, or approved equal.

B. Concrete encased ground electrodes for all new buildings or structures having a concrete foundation shall be encased in the concrete foundation a minimum of 20 feet and tied to the foundation's steel reinforcing bar system. The concrete encased ground electrode shall be a minimum 3/4 inch diameter Type 316 stainless steel reinforcing bar per ASTM A955/A955M. The concrete encased ground electrode shall extend outside of the concrete foundation and turn up into a concrete encased

electrode accessibility ground port enclosure as shown on the PLANS. Refer to the PLANS for additional requirements. The enclosure shall comply with the requirements of Section 16130 of the Specifications “Boxes and Cabinets”.

C. Connections between ground electrode and grounding electrode conductors shall be made below grade using Cadweld, Burndy Thermoweld, or equal thermite reaction welding system. Exception: Connections between ground electrode and grounding electrode conductors made inside an accessible underground Grounding System Test Well, only where noted/detailed/shown on the PLANS, shall be permitted to be made with tin-plated Bolted Ground Lug connectors as manufactured by BURNDY Type GK, or approved equal.

D. Grounding electrode conductors/wire shall be green insulated RHW stranded copper. Use bare copper for grounding grids only (as shown on the PLANS).

E. Equipment and/or static voltage and/or any other ground buses/bars (for any other type of use) called for on the PLANS and Specifications shall be tin-plated copper.

2.02 GROUND ENHANCEMENT MATERIAL

A. The Contractor shall encase the underground ground electrodes with the hereinafter specified Ground Enhancement Material.

B. Material: Low resistance non-corrosive carbon based backfill material, free of concrete and bentonite. Material shall not require periodic wetting or other Owner intervention in order to maintain its conductivity.

C. Application: Suitable for use as backfill material in rocky, sand, gravel, and other high resistance soil types to lower the ground resistance. Suitable for use in horizontal and vertical trench applications.

D. Manufacturer: Harger Model “Ultrafill”, Erico “Ground Enhancement Material (GEM)”, or approved equal.

PART 3 EXECUTION

3.01 GENERAL:

A. Connect each Ground Bus/bar directly to the Grounding Network conduit routed in the duct bank system in addition to the Grounding System around the manhole/handhole, as also shown on the PLANS.

B. Extend a dedicated equipment ground wire, minimum size No. 6 AWG green insulated wire, from each Ground Bus/bar to each individual conduit system grounding bushings, each cable clamp, each support channel, etc. housed inside the associated electrical manhole/handhole. Also, refer to the PLANS

C. Ground all electrical and instrumentation equipment, including lights, receptacles, instruments, etc., with a separate equipment ground wire installed in the conduit with the power conductors.

D. Install grounding system electrically and mechanically continuous throughout. System neutral shall be bonded only at the building service transformer.

E. Ground lighting transformer neutrals to their housing and bond the housing to the equipment grounding conductor.

F. Connect equipment grounding conductors to ground bars or busses provided at panelboards, motor control centers, disconnect switches, switchgears, etc., from which the equipment is served.

G. Where the equipment has no facility to attach an equipment ground wire, use a Burndy Quicklug or equal. Clean the metal surface under the lug to bright metal so that good contact can be made. Repaint metal surfaces after the lug and connecting ground wires are installed.

H. Make ground connections to equipment by using ground lugs or ground bars, where they are provided.

I. Use a thermite reaction welding system process as previously specified to make connections to ground rods; and, at any joint or connection which will be inaccessible after the construction. Exception: Connect to Grounding System Test Wells as previously specified and as also shown on the PLANS. Do not cover until each connection has been inspected by the Owner.

J. Furnish bonding jumpers as shown or as otherwise required by the National Electrical Code "N.E.C." Use stranded copper wire.

K. Inside buildings and at above ground level and through concrete floor slabs, route the ground wire(s) in a conduit raceway system. Fill annular space between ground wire and conduit with Crouse Hinds, Nelson or Raychem watertight and flame-retardant sealant.

L. Connect ground wires entering outlet boxes in such a manner that removal of the receptacle will not interrupt the continuity of the grounding circuit. A grounding screw attached to the box, and used for no other purpose, may be used to accomplish this.

M. After ground wire connections have been made to equipment, to structures, in test wells and encased grounding electrode accessibility ground port enclosures, etc., the Contractor shall apply "3M" 1601 Clear-Color Fast Drying Sealer and Insulator, or approved equal corrosion resistant and moisture repelling electrical coating/spray to all exposed wiring and all wire connections, inclusive of mechanical and exothermic weld connections. Coordinate application with the Owner.

N. Test grounding in accordance with Section 16800. Maximum resistance to ground shall not exceed 2.0-ohms. At no additional cost to the owner, install additional ground rods over the number required by the PLANS, as necessary to accomplish the 2.0-ohms or less resistance.

O. Install a bonding jumper from the grounding lug of each Conduit-Grounding-Bushing to the ground bar or bus of each enclosure and/or equipment housing (such as pull

boxes, junction boxes, panelboards, switchboards, motor control centers, transformers, automatic transfer switches, instrument and control panels, etc.), as applicable. Instrument Grounds to be separate from power grounds. Instrument ground to be insulated up to the connection to the ground grid. Also refer to details shown on the Drawings. Bonding jumper wire for Conduit system Grounding-Bushings shall be STRANDED bare copper wire with minimum of 19-strands. Bonding jumper wire size as required by the National Electrical Code "N.E.C.", however, minimum wire size shall be #10 AWG.

P. Where Grounding System bare copper underground conductors pass through a transition from soil to concrete/mud slab concrete/flowable fill concrete/etc., the conductors shall be wrapped with 20 mil polyvinyl chloride based Pipe Tape using a 50 percent overlap. Pipe tape coverage shall be installed at the point of the transition and an additional 12 inches of distance beyond either side of the point of transition/contacted region. Pipe Tape shall be 3M Company No.51, or approved equal.

Q. Where shown on the PLANS, in addition to the Grounding Network shown on the PLANS, furnish and install one (1) separate concrete encased electrode grounding system and obtain City inspection prior to concrete placement of building grade beams or slab. Each said grounding system shall include 20 feet of 3/4 inch stainless steel rebar, routed horizontally and encased in a minimum of 4 inches of concrete, located above building foundation slab waterproofing and attached to the building foundation slab reinforcing steel bars. Additionally, each concrete encased electrode shall also extend vertically to finished grade and terminate at a concrete encased electrode accessibility ground port enclosure as shown on the PLANS. Label each enclosure cover "GROUND PORT" to comply with City of Austin Amendment to the National Electrical Code Ordinance 20170928-094 Article 250.68(A)(1).

R. Ground Enhancement Material Installation:
   1. All underground grounding electrodes shall be encased in an envelope of grounding enhancement material extending beyond the extents of the grounding electrode a minimum of 4 inches in all directions.
   2. Prior to installation, all ground enhancement material shall be mixed with water into a slurry in accordance with the ground enhancement material manufacturer's installation instructions. Salt water shall not be mixed with the grounding enhancement material.
   3. Refer to and comply with the installation details shown on the PLANS. Additionally, follow the ground enhancement manufacturer's installation instructions.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 16600

DISCONNECT SWITCHES AND ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install disconnect switches and enclosed circuit breakers as shown on the PLANS and specified herein.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. The PLANS designate the size, rating, and other requirements of the equipment specified under this Section.

D. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 of the Contract Specifications. For each individual Disconnect Switch and Enclosed Circuit Breaker include:
   1. Dimensioned/scaled fabrication drawings
   2. Ratings
   3. Wiring connection diagram
   4. Protective device coordination curves and current limiting circuit breaker/fuse peak current let through curves, where applicable.

B. Submit Operations and Maintenance Manuals (O&M) in accordance with Section 01730 of the Contract Specifications. Include:
   1. Copies of the approved shop drawings
   2. On-site/field test data.

PART 2 PRODUCTS

2.01 DISCONNECT SWITCHES

A. Construction:
   1. U.L. Listed, Non-fused, Single Throw, Heavy Duty type. Complies with UL98 and NEMA KS-1.
   2. Switchblades shall be fully visible in the "OFF" position when the door is open.
   3. Dead-front construction with permanently attached arc suppressors.
   4. Switches to have quick-make and quick-break operating mechanism and handles with provision for padlocking in all three positions, with at least four padlocks. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible.
   5. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door in an "ON" position from either source, or closing of the switch mechanism with the door open.
   6. Furnish lugs to terminate the incoming/outgoing field wiring as shown on the PLANS. Refer to the PLANS. Additionally, provide a grounding lug for equipment ground wire connection. Lugs to be U.L. listed.
   7. All current-carrying parts to be plated.

B. Ratings:
   1. Voltage Rating: 600 Volts A.C.
   2. Current Rating: Maximum continuous current capacity shown on the PLANS
   3. Number of Phases: Three, unless shown otherwise on the PLANS
   4. Minimum RMS symmetrical short circuit current rating: 10000 ampere at 208 volts A.C.

C. Enclosure:
   1. NEMA-4X Type 316-Stainless Steel gasketed cabinets.

D. Manufacturer:
   1. All Disconnect Switches on the project shall be manufactured by a single Disconnect Switch manufacturer.
   2. Square D Company Class 3110, Asea Brown Boveri, Eaton Cutler-Hammer Corporation, or approved equal.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Construction:
   1. Molded case type, NEMA rated, and U.L. Listed.
   2. Circuit breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. Breakers shall be thermal magnetic molded case type having inverse time thermal trip and instantaneous time magnetic trip. The design shall provide common tripping of all poles.
   3. Circuit breaker shall have handles with provision for padlocking in the ”OFF” position. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible. Circuit breakers shall have a dual enclosure interlock to prevent unauthorized opening of the

enclosure door when the circuit breaker is in the "ON" position, or closing of the circuit breaker mechanism with the door open.

4. Furnish lugs to terminate the incoming/outgoing field wiring as shown on the PLANS. Refer to the PLANS. Additionally, provide a grounding lug for equipment ground wire connection. Lugs shall be U.L. listed.

B. Enclosures: NEMA-4X type 316 Stainless Steel gasketed cabinet.

C. Circuit Breaker Ratings:
   1. Voltage Ratings: 600 volts A.C.
   2. Current Rating: Maximum continuous current carrying capacity shown on the PLANS
   3. Number of Phases: Three, unless shown otherwise on the PLANS
   4. Minimum RMS symmetrical short circuit current rating: Equal to or greater than that of bus serving the circuit breaker at rated bus voltage A.C.
   5. Breakers shall operate continuously when operating/running current is equal to 80% of the long time trip setting (or frame rating, as applicable) of the breakers.
   6. Provide complete with rating plug and other accessories as required for proper operation of circuit breaker.
   7. Furnish current limiting type circuit breakers when specifically required by the one-line drawings shown on the PLANS.
   8. Provide auxiliary contacts where required by the PLANS. Contacts shall be rated for 5 ampere at 120 volts A.C. Coordinate contact requirements with the PLANS.
   9. Provide electronic trip attachment where specifically shown on the PLANS. Trip unit shall be solid state type with adjustable long time, short time, instantaneous, ground fault and pick up settings as manufactured by **"**Square D" Micrologic LSIG Series B Trip Unit and Internal Ground Fault Protection, or approved equal.

D. Manufacturer: Circuit breakers shall be Square D Company Type FCL, Asea Brown Boveri, Eaton Cutler-Hammer Corporation, or approved equal.

2.03 IDENTIFICATION

A. General:
   1. Furnish and install identification nameplates for each piece of equipment as follows:
      a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
      b. Color: White-Black-White
      c. Lettering: 1/4 inch height, minimum, engraved through the face layer to the melamine middle layer.
      d. Accessories: Provide holes for mechanical fastening
      e. Attachment Means: Secured with two Stainless Steel screws.
   2. Exception: Identify manual motor starters mounted in environmentally controlled rooms as specified in Section 16300 "Wiring Devices".

PART 3 EXECUTION

3.01 INSTALLATION

A. Install where the top of each enclosure is no higher than 6-feet-0-inches above the finished floor elevation, unless otherwise noted on the PLANS.

B. Surface mount on support channels per the requirements Section 16150 “Raceways, Fittings and Supports” and the details shown on the PLANS. Also refer to details shown on the PLANS.

C. Tag equipment with the name as it appears on the PLANS using the specified nameplates.

3.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 16800

CALIBRATION, TESTING AND SETTINGS

PART 1 GENERAL

1.01 SUMMARY

A. Provide all equipment and labor required for calibration, setting and testing as described herein or otherwise required. All tests shall be witnessed by the OWNER or the OWNER's designated representative. Give written notification of the tests at least seven days prior to the desired date to perform the tests. Repair or replace all defective material, equipment or workmanship disclosed as a result of these tests at no cost to OWNER.

B. All work, including installation, connection, calibration, testing, and adjustment, shall be accomplished by qualified, experienced personnel working under continuous, competent supervision. The completed installation shall display competent work, reflecting adherence to prevailing industrial standards and methods.

C. Tests: The Contractor shall make all tests required by these specifications, or other authorities having jurisdictions. All such tests shall be performed in the presence of the OWNER or the OWNER's designated representative. The Contractor shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation.

1.02 SUBMITTALS

A. Submittals shall include copies of the test results/reports. Submittals shall be per the quantity and format requirements of Section 01300 and 01730 of the Specifications. Include the following at minimum:
   1. Test results, inclusive of catalog number/drawing cross-reference, where applicable, and any other data entered on the field test report
   2. Testing Plans
   3. All test instrument data sheets and calibration certificates

1.03 TEST PLAN AND TEST RESULTS

A. Performance: Testing shall be performed in compliance with the approved Test Plan. The Test Plan shall be submitted in accordance with the outline given below. Provide the OWNER with typewritten results of all tests, including a description of the equipment tested, the date and time of day tested, names of witnesses, weather conditions; and test values and results.

B. Test plan: At minimum, Submit a Test Plan for each of the Sections listed in Division 16 of these specifications. Test Plan shall be submitted at least two (2) weeks prior to the desired date and time of the test. Test Plan shall clearly identify the following, as applicable:
   1. Desired date and time to perform the test
   2. Name of Entity/individual that shall perform the test
   3. Test procedures and recording data sheets
   4. Name, description, catalog number, calibration date, and calibration entity's name of each of the test instruments to be used in executing the test
   5. Expected duration of the test
   6. Request for type, time and duration of any shutdown that may be required during the test.

C. Test Results: Submit Test Results for each of the Sections listed in Division 16 of these specifications. Test Results shall be submitted no later than at least two (2) weeks after the last date of the respective test. Test Results shall be typewritten and shall include the following, as minimum:
   1. All data and information provided in the Test Plan
   2. Name of Entities and individuals that attended and witnessed the test
   3. Weather Conditions
   4. Tabulated test values and results
   5. Corrective measures taken and/or to be taken toward defective material, equipment or workmanship disclosed as a result of these tests. Also include Re-Test dates and procedures for defective material, equipment or workmanship disclosed from the previous test.

1.04 TEST EQUIPMENT

A. Each test instrument shall have been certified by an established calibration laboratory within the six (6) months prior to its use in testing and calibration procedures. Calibration shall be traceable to the National Institute of Standards and Technology (NIST).

PART 2 PRODUCTS

A. No products are required by this Section of the Specifications.

PART 3 EXECUTION

3.01 INSULATION RESISTANCE (MEGGER) TESTS:

A. Use a minimum 500 volt megohmeter.

B. Take each reading for at least one minute.

C. Include the following tests:

Equipment	Minimum Resistance
115 and 230 volt motors	5.0 Megohms
460 volt motors	7.0 Megohms
600 volt transformer winding	100.0 Megohms
600 volt wiring up to 1000 ft.	25.0 Megohms

D. Coordinate minimum values shown with equipment manufacturer's recommendations.

E. Test all transformer windings as follows:
   1. Primary to ground
   2. Secondary to ground
   3. Primary to secondary

F. Record and submit all Megger readings to the OWNER/ENGINEER for review and record keeping purposes. Neatly type all readings and organize in a Database table form. Incremental megger readings shall also be recorded and included in the table.

3.02 GROUND TEST

A. Ground System testing shall be performed by an independent professional testing company specialized in, and well equipped to perform, ground resistance testing.

B. Ground testing shall assure resistance to ground values listed in the Grounding Specification. All tests must be witnessed by the Owner or the Owner's designated representative.

C. At a minimum, test each of the following separately, with ground under test isolated from other grounds:
   1. Each process area/building grounding network, i.e., Preliminary Treatment, Secondary Sludge, etc. Furnish and install additional grounding/ground electrodes if the resistance to ground measures more than the values stipulated in the Grounding Section of the Specifications. This shall be executed at no additional cost to the Owner.
   2. Each manhole grounding system
   3. Each handhole grounding system

D. Finally, after all tests of each individual process area/building, manhole, handhole, etc., are performed as previously specified, perform a final test after all of the individual process areas/buildings, manholes, handholes, etc. grounding networks are interconnected as also shown on the PLANS.

3.03 MOTORS

A. Test the insulation resistance (megger test) of all motors installed under this Contract inclusive of process mechanical drive motors and the Heating and

Ventilation System drive motors such as exhaust fans, fan and coil units drive motors, etc. Test all motors in accordance to with subsection 3.01 above.

B. Dry out any wet insulation by use of space heaters or other approved methods.

C. Check coupling alignment, shaft end play, lubrication, and other mechanical checks as required. Follow manufacturer's instructions.

D. Check for proper motor rotation.

3.04 RECEPTACLES

A. Test all receptacles for proper connections and grounding. Use an approved plug-in tester equal to Woodhead 1750 or Hubbell 5200.

3.05 CONTROL CIRCUITS

A. Check all circuits for continuity, proper connection, and proper operations.

B. Set all time delay relays and timers for the desired operations. Record the settings, indicating the relay or timer, its location, and the setting used. Verify all settings with a stopwatch.

3.06 CONTINUITY TESTS

A. Perform continuity test on all low voltage conductors (600 volt, and below, wiring system). Continuity test must be performed after wiring is pulled in the conduit system and/or underground electrical system (as applicable). Continuity test must be performed on each conductor between its source and final destination (point of termination to load/device/etc.). Utilize Ohmmeter for this test. Ohmmeter must be set to lowest ohm setting (highest resolution).

3.07 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 17100

PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS)

PART 1 GENERAL

1.01 SUMMARY

A. Provide all labor, materials, and equipment to design, furnish, install, calibrate, test, adjust, and place in operation the facility complete monitoring and control system as specified herein and as shown on the PLANS. The PLANS and Specifications show and specify those features required to illustrate and describe functional requirements of the monitoring and control system.

B. A single Instrument and Control System Contractor (ICS) shall furnish all services and equipment defined herein and in other Specification sections as listed below under Related Work. The Instrument and Control System Contractor is referred to herein and after (in Division 17 of the Specifications) as the ICS, ICS supplier/firm, or Contractor. The ICS shall have the qualifications as described in subsection 2.0, "Quality Assurance", this Section of the Specifications.

C. The ICS shall also:
   1. Terminate and tag all field wiring associated with the process instrumentation and control system shown on the PLANS and specified herein and in other Specification sections listed below under Related Work**.** This includes, but may not be exclusive to, termination and tagging of instrumentation and control system wiring within, inside and at:
      a. Proposed Main Instrument Control Panels in the proposed Substation No. 1 Electrical Building and the proposed Administration Building Electrical Room and Server Room, as shown on the PLANS.
      b. Proposed Lighting Contactor Control Panels in the proposed Substation No. 1 Electrical Building and the proposed Administration Building Electrical Room, as shown on the PLANS.
      c. Renovated Main Instrument Control Panel in the existing Operations Building Electrical Room, as shown on the PLANS.
      d. Proposed local control panels at the Aeration Basins, the Influent Lift Station, the Plant Drain Pump Station and the Scum Pump Stations, as shown on the PLANS.
      e. Proposed manufacturer packaged control systems throughout the various process areas of the plant, as shown on the PLANS.
      f. Proposed Field Control Stations throughout the various process areas of the plant, as shown on the PLANS.
   2. Tag Instrumentation and control wiring/cable per the requirements and methodology/scheme outlined in specifications Section 16205 "Wire and Cable Tagging".
   3. Calibrate, set and test the PICS equipment, components, cables, hardware, and software.
   4. For all PICS equipment and ancillaries, provide:
      a. Required submittals.

b. Equipment and ancillaries.
c. Instructions, details, and recommendations to, and coordination with, all other installation entities for Certificate of Proper Installation.
d. Certifying readiness for operation.
e. Starting up.
f. Testing.
g. Training
h. Use of testing/calibration equipment to facilitate calibration/testing of field sensors and instruments. Equipment shall include, but not be limited to:
    1) Test pressure pump for field calibration/testing of pressure transmitters.
    2) Signal generator/multi-function meter for field calibration/testing of resistance temperature detector (RTD) monitoring devices
    3) Temperature/heat generator for field calibration/testing of temperature transmitters.
    4) Shaker table for vibration transmitters, etc.

5. Provide special additional services during installation, including:
    a. Verifying that the following are furnished and installed:
        1) Correct type size, and number of signal wires with their raceways.
        2) Correct electrical power circuits and raceways.
        3) Correct size, type, and number of PICS related pipes, valves, fittings, and tubes.
        4) Correct size, type, materials, and connections of process mechanical piping for in-line primary elements
    b. For equipment not provided by the ICS, but directly connected to the PICS:
        1) Obtain manufacturer's information regarding installation, interface, function, and adjustment for equipment from the Contractor.
        2) Coordinate with Contractor to allow required interface and operation with the PICS.
        3) Verify that installation, interfacing signal terminations, calibration, and adjustments have been completed in accordance with the manufacturer's recommendations.
        4) Test to demonstrate the required interface and operation with the PICS.
        5) Examples of equipment in this category include, but are not limited to the following:
            a) OWNER's Top-End Computer System
            b) Motor Control Centers
            c) Uninterruptible Power Supplies
            d) Automatic Transfer Switches
            e) Process/Mechanical Equipment
6. Provide equipment, software, and services for the installation of the DCS configuration system at the ENGINEER's Austin, Texas office.
7. Assist OWNER/ENGINEER, as specified in applicable DCS subsystem specifications sections, in the PAT testing of the Applications Software which shall be developed by OWNER/ENGINEER for the DCS and Laptop Computer (as applicable).

D. Extensive field verification is required for all modifications to existing control panels. The ICS shall include effort associated with field verifying spatial dimensions inside the existing control panels for proposed equipment, wiring terminations, loop power supply sizes, loads on existing instrument loops, points of connections to existing equipment, etc. as required to support the proposed modification effort associated with this project. The ICS shall field locate proposed equipment to be installed inside the existing control panel as also shown on the PLANS. The proposed location shall be coordinated with the arrangement of the existing control panel internal and externally mounted components.

E. The OWNER's existing distributed control system is vital to the OWNER's treatment plant process system. Therefore, required interruptions to the OWNER's existing distributed control system shall be minimized and coordinated with the OWNER. Should an outage to a facility be required, the Contractor shall request such an outage in writing no less than four (4) weeks in advance. Contractor's written request shall identify the desired date, time, duration, and purpose of the requested day unless he/she obtains a written approval from the owner authorizing the outage. The OWNER reserves the right to modify or reject any request such an outage. Modification or rejection of the contractors request by the OWNER shall not be considered reason for delays in the construction schedule. Unless otherwise noted, the duration of the outage shall be limited to four (4) hours or less. The OWNER reserves the right to limit the duration of the outage to less than 4 hours. Modification of the outage duration by the OWNER shall not be considered reason for delays in the construction schedule.

F. The OWNER's existing distributed control system equipment and its associated interconnect wiring, power supplies, fuses, etc., is in perfect working condition. Should the existing equipment, its associated interconnect wiring, power supplies, fuses, etc., as applicable, be damaged or become otherwise unusable during the construction course of this project, the ICS shall determine the problem, correct it, and furnish and install all necessary wiring/hardware/etc., to match existing and make all final connections such that all affected equipment operates as previously operated to the OWNER's satisfaction at No Additional Cost to the OWNER.

G. Certain equipment shall be purchased and shipped under a SCADA Bid Allowance. Refer to Section 300L "Bid Form" of the Contract Specifications. In addition to being shown on the Bid Form, the equipment are also identified in their respective Division 17 specifications. The Contractor shall be responsible for additional aspects of work related to the equipment purchased and shipped under the SCADA Bid Allowance. This work shall be all associated work and costs other than the purchase and shipment of the equipment identified in the Bid Allowance to the suppliers address. The SCADA Allowance related work that shall be included in the Contractor's Base Bid includes, but is not limited to, the following:
    1. Coordination with manufacturers, vendors, Owner, Engineer, other Contractors and sub-contractors, etc. This coordination shall include all forms of communication such as meetings, conference calls, long-distance telephone calls, facsimile transmission, mail, mileage fees, delivery fees, postage, certified mail, electronic mail, transmittal of shop drawings to other contractors, etc., that may be required.
    2. All scheduling aspects and coordinating all associated schedules

3. Development and submittal of forms, shop drawings, O&M manuals, test reports, equipment arrangement drawings, floor plan layouts, etc., for the equipment as required.
4. Effort associated with incorporating the equipment into the project wiring diagrams, panel elevations, record drawings, equipment schedules, etc.
5. Purchase, delivery, storage, bond, insurance, packing/un-packing, loading/unloading, verification of equipment delivered, etc., as applicable, associated with the equipment
6. Costs associated with company overhead/profit, supervision of labor, etc., for each entity/company associated with the equipment
7. Assembly, installation, startup, testing, mounting hardware, cables, connectors, terminations, accessories, etc., associated with the equipment and achieving a complete and functional installation of the equipment at the project site.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Division-16 ELECTRICAL SPECIFICATIONS

D. Division-17: INSTRUMENTATION AND CONTROL SPECIFICATIONS

E. All other divisions of the Specifications related to the installation of the process mechanical equipment, etc. that are related to the operation of the instrumentation and control system.

F. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. General:
1. Do not design, manufacture, or ship any PICS equipment until all related submittals have been reviewed and approved by the ENGINEER. Submit shop drawings and product data in complete functional packages; i.e., submit all shop drawings and product data for a given loop or subsystem together as a functional package. Piecemeal submittals not organized by systems or incomplete submittals for a given loop or subsystem will not be accepted.
2. All system layout drawings, cross sectional view drawings, wiring diagram drawings, Connection detail drawings, physical layout and detail drawings, etc. shall be developed electronically using "AUTOCAD software".

B. Administrative Submittals:
   1. Schedule of Values
      a. Purpose: Project Schedule of Values to provide a basis for Partial Payment for Work completed.
      b. Content: Summary of major milestones and associated Partial Payments for Work provided under PICS Subsystems.
   2. PICS Progress schedule
      a. Purpose: Supplement the overall Project Progress Schedule to:
         1) Coordinate activities between the Contractor and the ICS
         2) Coordinate interactions with the OWNER/ENGINEER for coordination meetings, submittal reviews, etc.
         3) Clarify required work sequences and major milestone prerequisites.
      b. Provide multiple submittals of the project schedule throughout the duration of the Project as required.
   3. OWNER Training Plan: Submit description/schedule of OWNER Training to be provided.
   4. Statements of Qualification: Submit for PICS firm, site representative, start-up and testing team member.

C. Submit shop drawings in accordance with Section 01300 of the Specifications and as specified below:
   1. Detailed product data, catalog cut sheets, cabinet exterior and interior front elevations, bill of materials, and spare parts list
   2. Point-to-Point Wiring Diagrams: Prepare Point-to-Point Instrument Loop Wiring Diagrams, ladder diagrams (control schematics), cabinet wiring, and other field wiring diagrams in accordance to the format shown on the PLANS. Drawings shall be neat, and legible, and on 11 inch x 17 inch sized sheets. Drawings to include all relevant information for equipment connected to the PICS, regardless if the equipment is provided by the ICS or not, i.e., include motor control centers, OWNER pre-purchased equipment, etc. Contractor shall also submit for approval a complete schedule of all wire tag numbers sorted by area and equipment/instrument/field device.
   3. Although typical control schematics/instrument loops are presented on the PLANS for some equipment, the Contractor shall generate specific equipment control schematic drawings/instrument loops (i.e., individual control schematic/instrument loop drawings dedicated for each specific equipment) based upon the typical control schematic/instrument loop drawings, the device identification/tag replacement schedules shown on the PLANS, and the additional requirements described herein. The Contractor generated specific equipment control schematics/instrument loops shall follow the same overall presentation format as the typical equipment control schematics/instrument loops presented on the PLANS. The specific equipment control schematics/instrument loop drawings complete with all specific equipment/device tags (as a minimum, also refer to the additional requirements described herein) shall be generated by the Contractor and included with the project submittals (i.e., prior to equipment purchase) and the "As-Built" drawings. Any Contractor generated control schematic/instrument loop shown as applicable for multiple equipment shall not be accepted.
   4. Contractor may submit wire tag samples for all types of interconnect and field wiring from the proposed/existing cabinets/panels with associated point-to-point wiring diagrams in a separate submittal for approval prior to submitting

the complete wire tag schedule for review. After approval of the sample wire tags, a wire tag table showing all provided wire tags shall be submitted for review with the associated point-to-point wiring diagrams. Refer to Subsection 1.03.C.5, this Section of the Specifications for additional wire tag table requirements. Refer to Specification 16205 for wiring tagging methodology.

5. Wire Tags: Contractor shall also submit for approval a complete schedule of all wire tag numbers sorted by area and equipment/instrument/field device. It is anticipated that all wire numbers cannot be accommodated on the loop diagrams, ladder diagrams, control schematics, etc. format shown on the PLANS. As a minimum, to facilitate the depiction of the wire numbers on the loop diagrams, ladder diagrams, control schematics, etc., the Contractor shall generate and include uniquely identified alpha-numeric wire codes on the loop diagrams, ladder diagrams, control schematics, etc. The wire codes shall cross-reference tables of wire numbers shown on additional drawings that shall be generated by the Contractor. At minimum, the Contractor shall generate the wire codes and the cross-reference tables which depict the wire numbers associated with each wire code and shall group the cross-reference tables by specific equipment (Sludge Pump No. 1, Sludge Pump No. 2, Sludge Pump No. 3, etc.). As a minimum, the Contractor shall generate drawings to depict the wire code and wire tag cross-reference tables and these drawings shall also be grouped by specific equipment (Sludge Pump No. 1, Sludge Pump No. 2, Sludge Pump No. 3, etc.). Additional requirements concerning the cross-reference table headings, table organization, wire code generation, formatting, etc., shall be provided by the Owner during the Pre-Submittal Conference specified hereinafter (*refer to subsection 1.03G in this Section of the Specifications*) and the Contractor shall incorporate these requirements at no additional cost to the Owner. Contractor shall submit wire tag samples for all types of interconnect and field wiring from the proposed/existing cabinets/panels with associated point-to-point wiring diagrams in a separate submittal for approval prior to submitting the complete wire tag schedule for review.

D. Testing Related Submittals:
   1. Submit factory and field calibration reports
   2. Submit the following for each of type of test (ORT and PAT) required under Division 17 of the Specifications:
      a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
      b. Final Test Procedures: Proposed test procedures, forms, and checklists.
      c. Test Documentation: Copy of signed off test procedures when tests are completed.

E. Training Related Submittals:
   1. Submit the following for each type of training required under Division 17 of the Specifications:
      a. Training plan, course topics, subjects to be addressed in the training
      b. Schedule
      c. Training agenda for each course
      d. Instructor qualifications
      e. Listing of available training courses and outline of course topics and agendas

F. Submit Operation and Maintenance manuals in accordance with Section 01300 and 01730 of the Specifications and as specified below:
   1. Include approved shop drawing data in the Operation and Maintenance manuals with the following modifications to the shop drawing exhibits:
      a. Reflect “As-Built” conditions.
      b. Prints of exhibits, wiring diagrams, etc. shall be half size (11 inch by 17 inch).
      c. Submittals shall include hard copies (of the quantity and format required by the Contract Documents) and electronic Version in “AUTOCAD”; This applies to all drawings requested in this Section of the Specifications and any other manufacturer’s product standard drawings required for submittal.
   2. Procedures for operating and shut-down
   3. Included approved Testing Related Submittals with final “As-Built” conditions.
   4. Safety instructions.
   5. Calibration instructions and factory test results of each instrument.
   6. Maintenance and repair instructions.
   7. Recommended spare parts list.
   8. Name, address and phone number of instrumentation control system supplier's local representative.
   9. Additionally, comply with the requirements of the Contract Documents.

G. Pre-submittal conference
   1. General:
      a. Review the manner in which the contract requirements will be met prior to preparation of submittals. The Contractor, Engineer, OWNER, and ICS shall attend. Schedule, conduct, and arrange the conference within 90 calendar days after receipt of written notice to proceed work is given by the OWNER.
      b. The ICS shall present the following at the conference:
         1) List of equipment and materials required and the brand that shall be used for each item
         2) Sample submittals from similar projects including the types of drawings/data/lists specified herein

1.04 SPECIAL CONDITIONS

A. All components used in the instrument and control systems shall be new (not used) and the current model produced by the manufacturer.

B. All equipment of a common type shall be the product of a single manufacturer.

PART 2 QUALITY ASSURANCE

2.01 ACCEPTABLE PROCESS INSTRUMENTATION AND CONTROL SYSTEM (PICS)

A. Provide a complete, workable, and installed-in-place Process Instrument and Control System, hereinafter referred to as the PICS, as specified herein. The PICS shall be designed, installed, and started up by the single ICS firm.

B. Acceptable ICS firm shall have the following minimum qualifications:
   1. ICS Firm: Minimum of 5 years experience in providing, integrating, installing, testing, and start-up similar systems as those required for this project
   2. ICS Firm Site Representative: Minimum of 8 years experience installing similar systems as those required for this project
   3. ICS Firm Start-up and Testing Team Members: Minimum of 3 years experience in testing systems similar to those required for this project.

C. PICS meetings to be scheduled in accordance with the Contract Documents.

2.02 SYSTEM COORDINATION AND QUALITY

A. Coordinate installation of instrumentation with mechanical and electrical systems.

B. Coordinate subsystems to provide a complete operational and functional instrumentation system to the satisfaction of the OWNER and ENGINEER.

C. Equipment, instruments, components, and materials for PICS components shall be new (not used) and of the current model.

D. Instrument and Control Components Furnished By Others: Certain items of instrumentation and controls shall be furnished by various equipment manufacturers. Coordinate the purchase orders of the items such that the resulting system will function properly.

2.03 DESIGN CRITERIA

A. Design, construct, and install all PICS components in compliance with the applicable provisions of the following standards, codes, and regulations:
   1. American National Standards Institute (ANSI) Standards.
   2. American Institute of Steel Construction (AISC) Standards.
   3. American Society for Testing and Materials (ASTM) Standards.
   4. American Waterworks Association (AWWA) Standards.
   5. Joint Industrial Council (JIC) Standards.
   6. National Electric Code (NEC)
   7. National Electrical Manufacturer's Association (NEMA) Standards.
   8. Local and State Building Codes.
   9. Occupational Safety and Health Administration (OSHA) Regulations.
   10. Scientific Apparatus Manufacturer's Association (SAMA) Standards.
   11. International Society of Automation (ISA) Standards.
   12. National Fire Protection Association (NFPA)
   13. Institute of Electrical and Electronics Engineers (IEEE).

2.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Enclose cabinets and subassemblies in heavy polyethylene envelopes to protect them from dust and moisture. Place corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

B. Storage: All materials and equipment shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment. The Instrument Control Panels and the field control and instrument/monitoring panels shall not be moved `from climate controlled storage room to the project site until the construction of each electrical/control room is completed, and, the air-conditioning and heating system of the facility is in an operating condition satisfactory to the OWNER and ENGINEER.

2.05 CALIBRATION INSTRUMENTS

A. Each instrument used for calibrating PICS equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous twelve (12) months to a standard endorsed by the National Institute of Standards and Technology (NIST). At OWNER's request, ICS shall submit calibration certification report.

2.06 START DATE OF THE PROCESS INSTRUMENTATION AND CONTROL SYSTEM AND ASSOCIATED SUBSYSTEM WARRANTY (PICS INCLUDING SUBSYSTEMS)

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Procurement Documents.

PART 3 SEQUENCING AND SCHEDULING

3.01 GENERAL

A. All work provided under this section shall be in accordance with the OWNER/ENGINEER-approved Schedule of Submittal Submissions and Schedule of Values.

B. Specification and Construction Implementation Plan requires phased installation of equipment and systems. Stage all PICS activities (submittals, fabrication, installation, testing, start-up, training, etc.) to support the construction sequencing requirements of the project.

C. Wherever language in this section refers to the PICS, the entire installed PICS, the entire PICS, or similar language, it shall be interpreted to apply to the individual phases of the work; except the requirements for the Performance Acceptance Test (PAT).

D. Key milestone dates associated with PICS activity shall be included in the overall project schedule. Include the following dates as a minimum:
   1. ORT start and end date
   2. PAT start and end date
   3. Date Configuration System is delivered to the Engineer
   4. Date Configuration System is expected to be retrieved from the Engineer.
   5. Training dates

3.02 PREREQUISITE ACTIVITIES AND LEAD TIMES:

A. Start the following key Project activities when prerequisite activities and lead times listed below have been completed and satisfied:
   1. Shop Drawings submittal prerequisite: Completion of the Pre-submittal conference
   2. Test Prerequisite:
      a. All associated process and mechanical equipment, controlled and monitored by the instrumentation and control system, complete in place
      b. Associated test plan submittal completed. For ORT and PAT, notice of test schedule required 4 weeks prior to the start of test
   3. ORT Prerequisite:
      a. Approved ORT test procedures
      b. Approved ORT test forms
      c. 30 calendar days advance written notice to given to OWNER of impending ORT.
   4. PAT Prerequisite:
      a. Six (6) months minimum elapsed time after delivery of Configuration System to Engineer's office.
      b. ORT successfully completed.
      c. Approved PAT test procedures
      d. 30 calendar days advance written notice to given to OWNER of impending PAT.
   5. O&M submittal prerequisite: PAT successfully completed.

B. Configuration System Delivery: Deliver the entire Configuration System to the Engineer's office no later than 90 days after the completion of the Pre-Submittal Conference.

PART 4 PRODUCTS

4.01 GENERAL

A. Refer to requirements of PICS Subsystem provided in Division-17 Specifications.

4.02 SOURCE QUALITY CONTROL

A. General:
   1. Test all PICS elements, both hardware and specific software, to demonstrate that PICS satisfies all requirements.
   2. On-Site Tests Described Under PART 5 - EXECUTION:
      a. Operational Readiness Test "ORT"
      b. Performance Acceptance Tests "PAT".
   3. Test Format: Cause and effect
      a. Person conducting test initiates an input (cause)
      b. Specific test requirement is satisfied if the correct result (effect) occurs
   4. Procedures, Forms, and Checklists:
      a. Conduct all tests in accordance with, and documented on, ENGINEER accepted procedures, forms, and checklists.
      b. Describe each test item to be performed.

c. Have space after each test item description for sign off by appropriate party after satisfactory completion.

5. Required Test Documentation: Test procedures, forms, and checklists. All signed by OWNER/ENGINEER and Contractor.
6. Conducting Tests:
   a. All special testing materials and equipment.
   b. Wherever possible, perform tests using actual process variables, equipment, and data.
   c. If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
   d. Define simulation techniques in test procedures
   e. For PICS Subsystems for which OWNER provides applications software, provide sufficient temporary software configuring to allow for ORT testing of these subsystems.
7. OWNER/ENGINEER will actively participate in many of the tests.
8. OWNER/ENGINEER reserves the right to test or retest all specified functions whether or not explicitly stated in the Test Procedures.
9. OWNER's/ENGINEER's decision will be final regarding acceptability and completeness of all testing.

B. Maintenance of Configuration System (as defined in Section 17600 "Distributed Control System):
   1. Provide for maintenance of the Configuration System at the ENGINEER's office. Repair or replace failed equipment within two days of notice by ENGINEER..

C. Provide field support during OWNER/Engineer testing of installed applications software

PART 5 EXECUTION

5.01 EXAMINATION

A. Equipment furnished by Supplier or any other subcontractor and installed by the ICS/Contractor, requires Supplier to observe and advise on installation to extent required to certify that equipment has been properly installed and will perform as required.

B. For equipment not provided by the ICS, but that directly interfaces with the PICS, verify the following conditions:
   1. Proper installation.
   2. Calibration and adjustment of all instrumentation and control devices.
   3. Correct control action.
   4. Switch settings.
   5. Opening and closing speeds and travel stops.
   6. Input and output signals.

5.02 INSTALLATION

A. Material and Equipment Installation:
   1. Follow manufacturer's installation instructions, unless otherwise indicated or directed by the OWNER/ENGINEER
   2. Retain a copy of the manufacturer's instructions at the project site, available for review at all times.

B. Wiring:
   1. All wiring connected to PICS components and assemblies shall be in accordance to the requirements of Division 16 and 17 of the Specifications.

5.03 FIELD QUALITY CONTROL

A. General: All requirements listed in Subsection Source Quality Control, above, also apply to this Subsection, Field Quality Control.

B. Onsite Supervision:
   1. The ICS Project Site Representative shall supervise and coordinate all onsite PICS activities.
   2. The ICS Project Site Representative shall be On-Site during total period required to complete all On-Site PICS activities.

C. Startup and Testing Team:
   1. Thoroughly check installation, termination, and adjustment for all PICS Subsystems and their components.
   2. Completed On-Site tests.
   3. Provide and conduct startup services
   4. Complete onsite training.

D. Sequence of Work: Provide individual ORTs and PATs for individual process equipment where required to support the staged construction and startup of the facility. Coordinate the construction sequencing requirements with the OWNER.

E. Specialty Equipment: For certain components or systems provided under this Section but not manufactured by the ICS, provide services of qualified manufacturer's representative during installation, start-up, testing (both ORT and PAT) and OWNER's training. For example: RTD calibrator, vibration shaker table (which may be furnished/operated by vibration sensor manufacturer representative), pressure calibrator, etc, shall be provided as required.

F. Operational Readiness Test (ORT):
   1. Prior to start of the Performance Acceptance Test "PAT", the ICS firm shall inspect, test the PICS equipment and systems, document the resulting tests performed, implement all corrective actions necessary, perform all associated re-testing, and document that the PICS is installed and ready for operation. Subsequent to the ICS documentation that the PICS is installed and ready for operation, perform jointly with the OWNER an ORT on the associated PICS equipment to demonstrate that it is fully operable as required by the Contract Documents.

2. For PICS subsystems where the PLC application software is provided by the OWNER, provide sufficient temporary software configuring to allow testing of these subsystems.
3. Loop/Component Inspections and Tests:
    a. Check PICS for proper installation, calibration, and adjustment on a loop-by-loop, and component-by-component basis.
    b. Develop and provide forms as required to document ORT. All forms generated shall have provisions for signature by PICS representative.
    c. Develop and provide test form hereinafter called the “Loop Status Report” to organize, track inspection, adjustment, and calibration of each loop. Loop Status Report shall include the following as a minimum:
        1) Project name
        2) Loop number
        3) Tag number for each component
        4) Checkoff/signoffs for each component:
            a) Tag/identification
            b) Installation
            c) Wiring termination
            d) Tubing termination
            e) Calibration/adjustment
        5) Checkoffs/signoffs for each loop:
            a) Panel interface termination
            b) PLC I/O interface terminations
        6) PLC I/O Signals are Operational: Received/sent, processed, adjusted
        7) Total loop operational
        8) Space for comments.
    d. Develop and provide test form hereinafter called the “Component Calibration Sheet” to organize, track inspection, adjustment, and calibration of each component (except hand switches, pilot lights, gauges, and similar items) and each PLCs I/O Module. The Component Calibration Sheet shall include the following as a minimum:
        1) Project Name
        2) Loop Number
        3) Component tag number or I/O module number
        4) Manufacturer name
        5) Model number/serial number
        6) Summary of functional requirements. For example:
            a) Indicators
            b) Transmitters/converters, input and output ranges
            c) Computing elements’ functions
            d) Controllers, action (direct/reverse) and control modes (P&ID)
            e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual)
            f) PLC I/O modules: input or output
        7) Calibrations, for example, but not limited to:
            a) Analog devices: Actual inputs and output at 0, 25, 50, 75, and 100 percent of span, rising and falling
            b) Discrete Devices: Actual trip points and rest points
            c) Controllers: Mode settings (P&ID)

d) PLC I/O Modules: Actual inputs or outputs of 0, 25, 50, 75, and 100 percent of span, rising and falling.

8) Space for comments

e. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at the project site and make them available to the OWNER at all times.

f. These inspections and tests, inclusive of the above described forms, will be spot checked by the OWNER.

g. The ICS shall implement all corrective measures needed and perform re-test on any modified sub-system/component.

h. The Contractor shall claim and validate a thorough ORT was performed successfully and all resulting corrective action measures taken were performed successfully and re-tested successfully. Upon successful completion of the ORT, the Contractor shall submit letter notification to the OWNER stating that the ORT has been successfully completed. The letter notification shall further state that the ICS is ready to begin the Performance Acceptance Test. Submit all forms upon completion of ORT as required by the OWNER.

G. Performance Acceptance Tests "PAT":

1. Once the ORT has been successfully completed, perform jointly with the OWNER a PAT on the associated PICS to demonstrate that it is operating as required by the Contract Documents. The PAT will employ the OWNER's PLC application software developed for the project.
2. Minimum duration of the PAT shall be a cumulative total of ninety (90) calendar days. The cumulative total quantity of calendar days shall be consumed in association and in synch with the overall construction sequence for the project. Any Holidays that occur during the PAT shall result in a corresponding number of days being added to the duration of the PAT. The PAT encompasses startup and testing period of the instrumentation and control system for the associated process and mechanical equipment that are controlled and monitored by the instrumentation and control system. The PAT shall be conducted using application software developed by the Engineer. The ICS shall test functions installed and the hard-wired system and the entire associated instrumentation and control system including validating the operation and monitoring and control functions of the all instruments, all control devices, all instrument and control components, control functions, alarm function, monitoring function, calibration ranges, control/alarm setpoint operations, etc. OWNER/Engineer shall test software functions. The ICS shall also test the DCS.
3. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis based upon the operating description used by the OWNER for PLC application software development.
4. Non-loop specific tests shall be the same as previously required except that the entire installed PICS shall be tested using actual process variables and all functions demonstrated.
5. Perform local and manual tests for each loop before proceeding to remote and automatic modes
6. 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.

7. Make updated versions of documentation required for PAT available to the OWNER at the project site, both before and during tests.
8. Develop and provide PAT test forms that include the following, at minimum:
   a. Project name
   b. Lists the requirements of the loop
   c. Briefly describes the test
   d. Cites the expected results and the actual results
   e. Provides space for checkoff by witnesses.
9. Make one copy of all O&M manuals available to the OWNER at the site both before and during testing.
10. The ICS shall implement all corrective measures needed and perform re-test on any modified system.

5.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 17101

SPECIFIC CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loop descriptions:
      a. Specific control requirements and functional descriptions for individual control loops.

1.02 REFERENCES

A. As specified in Section 13390 - Packaged Control Systems and Section 17100 - Process Instrumentation and Control Systems.

1.03 DEFINITIONS

A. As specified in Section 17100 – Process Instrumentation and Control Systems.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS (NOT USED)

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 INSTALLATION, APPLICATION, CONSTRUCTION

A. Influent Lift Station
   1. References:
      a. 10M01, 10N01, 10N02.
   2. Abstract:
      a. General Control: Lift station pumps shall be started and stopped manually or automatically based on feedback provided by level sensors. When the water level reaches a preset elevation, a pump is turned on. Additional pumps shall be started when the water level reaches additional set point elevations. Pumps are stopped when the water level drops to the set point elevation.
      b. There are a total of five pumps. Two pumps are jockey pumps and will always be the lead and lag1 pumps, unless a pump is offline. Three pumps are large duty and one is standby. The selection of lead (jockey 1), lag1 (jockey 2), lag2, lag3 and standby pumps can be made through the SCADA interface.
      c. The influent pumps shall utilize reduced voltage solid-state starters.
   3. Hardwired control:
      a. Each pump will be equipped with a field control station (FCS) equipped with a Hand-Off-Auto selector switch. When the FCS selector switch is in Hand, the lift pump will run immediately.
      b. A reset button at the FCS will reset the Motor High Temperature and Motor Moisture alarms.
   4. Hardwired interlocks:
      a. Refer to E and N drawings.
   5. PLC control (Remote Auto):
      a. In PCIS AUTO, the pump is controlled via the PLC:
         1) When the water level in the wet well is above the lead pump position start elevation, the lead pump is started.
         2) If the water level continues to rise, when it reaches the lag pump start elevation, the lag pump is started.
         3) If the water level continues to rise, when it reaches the lag2 pump start elevation, the lag-lag pump begins operation.
         4) If the water level continues to rise, when it reaches the lag3 pump start elevation, the lag-lag-lag pump is started.
         5) If the water level continues to rise, when it reaches the high high position, an alarm is initiated.
         6) If the water level drops, when it reaches the lag3 pump stop elevation, the lag3 pump is stopped.
         7) If the water level continues to drop, when it reaches the lag2 pump stop elevation, the lag2 pump is stopped.
         8) If the water level continues to drop, when it reaches the lag pump stop elevation, the lag pump is stopped.

9) If the water level continues to drop, when it reaches the lead pump stop elevation, the lead pump is stopped.
10) When the water level drops to the low-low alarm elevation, all pumps force to stop and an alarm is initiated.
11) Upon the stop of the lead pump, the pump positions rotate with the lead jockey pump going to lag1 position, the second jockey pump going to lead position and the other pumps shifting one position.

6. Software interlocks:
   a. As indicated on the Drawings.
7. DCS control:
   a. As indicated on the Drawings.
8. Indicators and alarms:
   a. As indicated on the Drawings.
9. Failure modes:
   a. As indicated on the Drawings.

B. Lift Station Odor Control:
1. Refer to Section 11395A - Pre-Engineered Single-Stage Biotrickling Filter Odor Control Systems for specific control description for Lift Station Odor Control.
2. Equipment Tags:
   a. Odor control system: LS-ODORCONTROL-01.
   b. Blower: LS-BLOWER-01.
   c. Recirculation pump: LS-RECYCLEPUMP-01.
3. Abstract:
   a. Lift station odor control system is a packaged system that includes one odor control unit, fan, recirculation pump, nutrient pump, and nutrient tank.
   b. The influent pump station odor control fan draws foul air from the influent lift station headspace. The fans are designed to draw 10 air changes per hour.
   c. The biotrickling filter shall be used to remove odorous compounds from air drawn from the headspace.
   d. The filter unit will contain an inorganic porous substrate to support a thin film sulfur oxidizing bacteria for the removal of H2S.
   e. The pumps for the irrigation and nutrient feed systems shall automatically start when the odor control fans are running to maintain a healthy microbial population. Irrigation is provided by the plant NPW and controlled by the water control panel. Nutrient feed is pumped only during startup of the biofilter and operates for an adjustable period of time, and can be ceased once the population is established.

C. Bar Screens:
1. Refer to Section 11327 - Multi-Rake Screens for specific control description for Bar Screens. Controls panels are shown on 20N01.

D. Screenings Washer Compactor:
1. Refer to Section 11333 - Screenings Washer Compactor for specific control description for Screenings Washer Compactor. Control panel is shown on 20N01.

E. Screenings Screw Conveyor:
   1. Refer to Section 14555 - Shaftless Screw Conveyor and Appurtenances for specific control description for Screenings Screw Conveyor. Control panel is shown on 20N01.

F. Vortex Grit Chamber:
   1. Refer to Section 11323 - Vortex Grit Chamber Equipment and Drawings for description of controls.

G. Grit Pump:
   1. References:
      a. 20N03 and Section 11323 - Vortex Grit Chamber Equipment.
   2. Abstract:
      a. General Control: In Auto control, grit pump will receive a start/stop command from the DCS. Frequency of pump starts and duration shall be field adjustable from the DCS.
      b. There are is one duty grit pump. A shelf spare backup pump will be provided.
   3. Hardwired control:
      a. Each pump will be equipped with a field control station (FCS) equipped with a Hand-Off-Auto selector switch. When the FCS selector switch is in Hand, the lift pump will run immediately.
      b. Refer to drawings for additional details.

H. Grit Washer:
   1. Refer to Section 11324 - Grit Washer for specific control description. Control panel shown on 20N03.

I. Headworks Odor Control
   1. Refer to Section 11395A - Pre-Engineered Single-Stage Biotrickling Filter Odor Control Systems for specific control description for Lift Station Odor Control.
   2. Equipment Tags:
      a. Odor control system: HW-ODORCONTROL-01.
      b. Blower: HW-BLOWER-01.
      c. Recirculation pump: HW-RECYCLEPUMP-01.
   3. Abstract:
      a. Headworks odor control system is a packaged system that includes one odor control unit, fan, recirculation pump, nutrient pump, and nutrient tank.
      b. The headworks odor control fan draws foul air from headspace in the headworks, channels, and headworks equipment including grit removal system. The fan is designed to draw 12 air changes per hour from the headworks channels, and 20 air changes per hour from screenings and grit area.
      c. The biotrickling filter shall be used to remove odorous compounds from air drawn from the headspace.
      d. The filter unit will contain an inorganic porous substrate to support a thin film sulfur oxidizing bacteria for the removal of H2S.
      e. The pumps for the irrigation and nutrient feed systems shall automatically start when the odor control fans are running to maintain a healthy microbial population. Irrigation is provided by the plant NPW and controlled by the water control panel. Nutrient feed is pumped only during

startup of the biofilter and operates for an adjustable period of time, and can be ceased once the population is established.

J. Anaerobic and Anoxic Zone Submersible Mixers:
   1. References:
      a. 30N02 through 30N07.
      b. Section 11317 – Submersible Mixers: High Speed.
   2. Abstract:
      a. Aeration Basin No. 1, No. 2, No. 3 and No. 4 each include a pre-anoxic zone (Zone 1), an anaerobic zone (Zone 2), an anaerobic/anoxic zone (Zone 3), an anoxic zone (Zone 4), and two aerobic zones (Zone 5 & Zone 6). Return activated sludge (RAS) is pumped from the RAS pump station and discharged into Zone 1, while headworks effluent flows into Zone 2.
      b. One submersible mixer will be installed into Zones 1 thru 4 per aeration basin to prevent settling of the mixed liquor suspended solids.
   3. Hardwired control:
      a. The mixers are designed to run continuously.
      b. A field control station (FCS) will be provided with Hand-Off-Auto switch, Running indicator light and E-stop, as shown on drawings.
      c. When selector switch is in Hand mode, mixer will run immediately.
   4. Interlocks:
      a. The mixer will shut down on motor thermal overload, motor high temperature and motor moisture.
   5. PLC control:
      a. When the FCS is in Auto position the mixer can be controlled manually through the PLC from the DCS Top-end computer.

K. Aeration Basin Blowers:
   1. Refer to Section 11375 - Single Stage Centrifugal Air Blowers for description of the vendor control panel and its interaction with the plant control system.
   2. Blower Tags:
      a. OPS-BLOWER-01.
      b. OPS-BLOWER-02.
      c. OPS-BLOWER-03.
   3. Abstract:
      a. The Aeration Blowers are controlled by the blower vendor master control panel (MCP) furnished and programmed by the blower vendor.
      b. The blower manufacturer shall be responsible for the Dissolved Oxygen Control System, as described in Section 11375 - Single Stage Centrifugal Air Blowers.
      c. Two duty and one standby blowers will discharge into a common header. Each blower will provide temperature which will feed the dedicated local blower VCP. The common header will have one pressure transmitter, which feeds the blower MCP.
      d. The blower MCP will accept control inputs from the plant PLC.

L. Aeration Basin Blower Valves:
   1. The aeration blower valves will be part of the dissolved oxygen control system which will be provided by the aeration blower manufacturer. Refer to Section 11375 - Single Stage Centrifugal Air Blowers for description of the vendor control panel and its interaction with the plant control system.

2. Valve Tags:
    a. AB-AB1-BFV-01.
    b. AB-AB2-BFV-01.
    c. AB-AB3-BFV-01.
    d. AB-AB4-BFV-01.
3. Associated Blower Tags:
    a. OPS-BLOWER-01.
    b. OPS-BLOWER-02.
    c. OPS-BLOWER-03.
4. Abstract:
    a. Blowers provide process air to four individual aeration basin (AB) trains, AB No. 1 through No. 4.
    b. A separate, independent control system provided by the blower vendor will start and stop blowers and will maintain header pressure or total airflow. Total air flow will either be determined by direct flow control or by selectable Dissolved Oxygen (DO) trim.
    c. The airflow to each aeration basin will be controlled by an individual electrically actuated butterfly valve using the most open valve methodology.

M. Mixed Liquor Recycle (MLR) Pumps:
1. References:
    a. 30N02.
    b. Section 11312X – Horizontal Propeller Pumps.
2. Abstract:
    a. Aeration Basin No. 1, No. 2, No. 3 and No. 4 each will include two duty, constant speed mixed liquor (ML) recycle pumps that pump mixed liquor from Zone 6 to Zone 3 or Zone 4.
    b. If Zone 3 is operating as an anaerobic zone, ML will be pumped to Zone 4. If Zone 3 is operating as an anoxic zone, ML will be pumped to Zone 3. Typical operation will be sending ML to Zone 3.
3. Hardwired control:
    a. The MLR pumps are designed to run continuously.
    b. A field control station (FCS) will be provided with Hand-Off-Auto switch, Running indicator light and E-stop, as shown on drawings.
    c. When selector switch is in Hand mode, pump will run immediately.
4. Interlocks:
    a. The pump will shut down on motor thermal overload, motor high temperature and motor moisture.
5. PLC control:
    a. When the FCS is in Auto position the pump can be controlled manually through the PLC from the DCS Top-end computer.

N. RAS Pumps:
1. References:
    a. 45N01 and 45N02.
2. Abstract:
    a. The RAS pumps transfer sludge from the secondary clarifiers to the RAS splitter box where RAS is passively split among four aeration basin trains.

b. There are two RAS pump stations, one existing pump station with 1/1 duty/standby pump configuration that pulls sludge from Secondary Clarifier No. 1 and one new pump station with 2/1 duty and standby pump configuration that pulls sludge from Secondary Clarifier No. 2 and No. 3. The duty and standby pumps will automatically alternate based upon an adjustable time interval.
c. An operator adjustable flow rate set point will be targeted by the pump. The set point will be based on an adjustable percentage of the raw influent flow as measured by the influent flow meter (Y-LSPI1-FIT-01).

3. Hardwired control:
   a. A field control station (FCS) will be provided with Hand-Off-Auto switch, Running indicator light and E-stop, as shown on drawings.
   b. When selector switch is in Hand mode, pump will run immediately.
4. Interlocks:
   a. The RAS pump will shut down on motor thermal overload, motor winding temperature, low suction pressure, and high discharge pressure.
5. PLC control:
   a. The magnetic drive speed is adjusted by the PLC based on a flow set point.

O. WAS Pumps:
1. References:
   a. 47N01.
2. Abstract:
   a. The constant speed WAS pumps will transfer sludge from the secondary clarifiers to either Sludge Holding Tank No. 1 or Sludge Holding Tank No. 2. Typical operation will pump WAS to Sludge Holding Tank No. 1.
   b. The 1/1 duty/standby pumps will automatically alternate based upon an adjustable time interval.
   c. The speed of the pumps will be controlled based upon a selectable pumping rate (gallons per day) with adjustable time intervals and durations.
3. Hardwired control:
   a. A field control station (FCS) will be provided with Hand-Off-Auto switch and Running indicator light, as shown on drawings.
   b. When selector switch is in Hand mode, pump will run immediately
4. Hardwired interlocks:
   a. The WAS pump will shut down on motor thermal overload, motor winding temperature or high torque.
5. PLC control:
   a. In Auto mode the pumps are automatically started or stopped by the PLC based on an automatic timer developed in the PLC.

P. Secondary Clarifier Mechanisms:
1. Refer to 11353 and Drawing 40N02 for specific control description for the Secondary Clarifier Mechanisms.

Q. Scum Pumps:
1. Refer to 11312C and Drawing 40N04 and 40N05 for specific control description for the Scum Pumps.

R. Disk Filters:
   1. Refer to Section 11366B - Cloth Media Filters for specific control description for the Disk Filters.
   2. Abstract:
      a. Secondary effluent flows by gravity from the filter splitter structure through the filter influent pipe into the disk filter unit. The filter basin contains a series of circular disks covered with a pile cloth media. Water passes through the media and is collected in a centertube. The filtrate flows by gravity through the centertube and over the effluent weir, into the effluent chamber prior to discharge.
      b. Solids are separated from the water by the filter panels mounted on the 2 sides of the disks. The solids are retained on the filter disks while the filtrate flows to the inside of the disks into the centertube. A backwash pump is used to remove solids that accumulate on the cloth media disks (Backwash Mode) and the floor of the filter basin (Solids Waste Mode).
      c. Two submersible pumps will be located in a sump inside the Filter Complex and will be automatically controlled to pump rainwater and washdown water out of the Filter Complex.

S. UV Disinfection:
   1. Refer to Section 11289 - Ultraviolet Disinfection System for specific control description for the Ultraviolet Disinfection System.
   2. Abstract:
      a. The ultraviolet disinfection system is made up of a single channel with four UV banks. The UV disinfection system disinfects the filtered effluent as it flows through the UV channel. The UV banks will turn on and off and the power delivered to each bank will be modified as needed based on the total plant flow from SCADA (sum of flows from the effluent flow meter [FIT-0900 and FIT-0901] and the NPW Plant Distribution flow meter [FLTR-NPWI1-FIT-01]).

T. Plant Water Pump Station:
   1. References: 65M01, 65N01.
   2. Abstract:
      a. Two duty and one standby constant speed pumps operate in a lead/lag configuration to circulate plant water through the plant distribution system. A pressure relief/recirculating valve (located on a 4-inch recirculation line off the NPW discharge header) provides for recirculation of flow back to the wet well when pressures exceed a set pressure. When operating in Remote Automatic mode, the lag pump will turn on when pressure on the NPW discharge header drops below a certain setpoint. When operating in Remote Automatic mode, the lag pump will be called to shut down when flow through the pressure relief/recirculating valve exceeds a user-defined flow setpoint.
   3. Hardwired control:
      a. A field control station (FCS) will be provided with Hand-Off-Auto switch, and Running indicator light, as shown on drawings.
      b. When selector switch is in Hand mode, pump will run immediately
   4. Hardwired Interlocks:
      a. A pump will shut down on motor thermal overload.

5. PLC control:
    a. When the FCS selector switch is in Auto position:
        1) The pumps are controlled via the PLC:
            a) The pumps shall operate in a lead/lag sequence interlocked to operate with pressure relief/recirculating valve (PRLV), pressure transmitter (), and flow transmitter (). The pumps shall operate in the following manner:
                (1) The lead pump will run continuously at all times. Excess flow not used in the plant will recirculate via the PRLV into the UV effluent channel.
                (2) When the NPW header pressure at PIT- 1003 falls below an operator-defined pressure setpoint (initial setting 80 psi), a *Start Sequence Timer* is started. When the *Start Sequence Timer* expires and the pressure is below the setpoint, the lag pump shall be called out to start. If the *Start Sequence Timer* is started and the pressure rises above the operator-defined pressure setpoint before the *Start Sequence Timer* expires the Start Sequence Timer shall reset.
                (3) When the recirculation flow rate detected by FIT-1004 exceeds a field-tunable pre-set flow rate, a *Stop Sequence Timer* is started. When the *Stop Sequence Timer* expires, the lag pump shall be called out to stop. The lag pump then become the lead pump. The operator may assign the lead pump manually at the HMI, or the lead pump may be automatically alternated by the SCADA PLC based on instantaneous runtime and rest time.
                (4) When the NPW header pressure at PIT- 1003 falls below an operator-defined low-low pressure setpoint (initial setting 65 psi) for greater than 60 seconds, any online pumps shall be shut off and an alarm shall be initiated. This is to protect the pumps from operating “off their curve” in the event of a pipe break or valve left open.

U. Thickening Feed Pumps:
    1. References: 70N01.
    2. Abstract: The thickening feed pumps pump WAS from sludge holding tank number 1 to the volute thickener or to sludge holding tank number 2. The two rotary lobe pumps are VFD driven.
    3. Hardwired control:
        a. When the FCS Hand/Off/Auto switch is in Hand position, the will run immediately. Speed control is set at the FCS with a speed potentiometer.
        b. When the FCS Hand/Off/Auto switch is in Auto position, the pumps are automatically started or stopped by PLC.
    4. Hardwired interlocks:
        a. High Temperature detection shall shut off the motors and prevent starting/restarting until alarm reset.
        b. High pressure switch activation on discharge shall off the motors and prevent starting/restarting until alarm reset.
        c. As indicated on the Drawings and Section 17100 - Process Instrumentation and Control Systems.

5. PLC control:
    a. When the FCS Hand/Off/Auto selector switch is in Auto position:
        1) The pumps are controlled via the PLC:
            a) Motor status is transmitted from the motor starter to the PLC for informational purposes.
            b) Motor starts automatically based on call to start command from volute thickener or the DCS.
            c) Motor speed setpoint is provided by the volute thickener PLC or the DCS.
            d) High level alarm at sludge holding tank number 2 will cause PLC to automatically stop pumps.
6. Failure modes:
    a. VFD Failure: In the case of a VFD failure, the VFD can be bypassed and the pumps can be run at full speed.

V. Loop 72 – Plant Drain Pump Station:
1. References: 72N01.
2. Abstract: The plant drain pump station collects filter backwash flows, and various plant drain flows in a wet well. Two constant speed submersible solids handling pumps operate in a duty-standby configuration to pump the collected water to the headworks. The duty pump will turn on and off based on the level in the wet well. A submersible level indicating transmitter (SHF-WW-LIT-01) will monitor the water level in the wet well. High and Low level setpoints will turn on and turn off the duty pump. A High-High level setpoint will turn on the standby pump. Two float level switches (SHF-WW-LSH-01 and SHF-WW-LSL-01) will serve as standby level instruments if the submersible level transducer fails. A magnetic flow meter located at the headworks (Y-YAPI-FIT-01) monitors the flow from the plant drain pump station.
3. Hardwired control:
    a. When the FCS Hand/Off/Auto switch is in Hand position, the pump will run immediately.
    b. When the FCS Hand/Off/Auto switch is in Off position, the pumps cannot be started or stopped at the LCP or at the DCS.
    c. When the FCS Hand/Off/Auto switch is in Auto position, the pumps are automatically started or stopped by PLC based on liquid level in the wet well.
4. Hardwired interlocks:
    a. The drain pumps will shut down on thermal overload, motor high temperature, motor moisture or low level.
    b. As indicated on the Drawings and Section 17100 - Process Instrumentation and Control Systems.
5. PLC control:
    a. When the FCS Hand/Off/Auto switch is in Auto position:
        1) The pumps are controlled via the PLC:
            a) Motor status is transmitted from the motor starter to the PLC for informational purposes.
            b) Pump starts and stops automatically based on the liquid level in the wet well as measured by the submersible level indicating transmitter.
                (1) At High level setpoint, duty pump is started.
                (2) At High-High level setpoint, standby pump is started.
                (3) At Low level setpoint, pump(s) stopped.

c) Two float level switches provide backup for the submersible level indicating transmitter.
   (1) If the High-High level switch is activated and the pumps are not on, then both pumps automatically start.
   (2) If the Low level switch is activated and the pumps have not turned off, then the pump(s) automatically stop.
d) The duty-standby configuration is automatically alternated between the two pumps based upon an adjustable runtime interval.

W. Loop 75 – Sludge Holding Tank Aeration Blowers:
1. Reference Drawings:
   a. 75N03, 75N04, 75N05.
   b. Section 17305: Flow Measurement: Thermal Mass.
   c. Section 15112: Butterfly Valves.
2. Blower tag numbers:
   a. SHF-BLOWER-01.
   b. SHF-BLOWER-02.
   c. SHF-BLOWER-03.
3. Associated instrument tag numbers:
   a. Air flow meters:
      1) Sludge holding tank number 1 air flow meter: Y-AIPI1-FIT-01.
      2) Sludge holding tank number 2 air flow meter: Y-AIPI1-FIT-02.
   b. Level instruments:
      1) Sludge holding tank number 1 ultrasonic level indicating transmitter: SHF-SLB1-LIT-01.
      2) Sludge holding tank number 2 ultrasonic level indicating transmitter: DIG-SLB1-LIT-01.
4. Abstract:
   a. The Sludge Holding Tank Blowers are controlled from the plant PLC as indicated on the P&IDs.
   b. One Blower 1 is dedicated to Sludge Holding Tank No. 1 while Blower 3 is dedicated to Sludge Holding Tank No. 2. Blower 2 is a standby blower for either tank. Air discharges into a common header and is directed to a specific sludge holding tank by butterfly valves. Each blower will have a dedicated temperature instrument which relays information to the dedicated LCP.
5. Hardwired control:
   a. A field control station (FCS) shall be provided and include a Hand-Off-Auto selector switch, speed setpoint potentiometer, speed digital indicator, RESET pushbutton, E-Stop pushbutton and indicator lights (Running and VFD fault).
   b. When the LCP Hand/Off/Auto switch is in Hand position, the blower will run immediately.
   c. The blower will operate at the last previously set airflow rate.
6. Hardwired interlocks:
   a. The blowers will shut down on motor thermal overload, low suction pressure or high discharge pressure.
7. PLC control:
   a. As indicated on the Drawings and specified in Section 17100 - Process Instrumentation and Control Systems.

b. The blowers are placed in the Auto mode by placing the Hand/Off/Auto switch at the MCC in Auto. The blowers are then started by the PLC.
c. In PLC AUTO:
    1) The blower will operate continuously with speed and air flow being controlled by a PID control loop to vary the air supplied to the sludge holding tank. The blowers will alternate between two aeration modes to maintain a minimum DO and keep solids suspended and well mixed: full air and minimum air. The timing for each mode will be operator selectable. The initial setting will be full air for 30 minutes and minimum air for 30 minutes.
        a) The Air flow Rate setpoint (Q in scfm) is calculated by the formula Q = V * X where:
            (1) V = Current sludge volume in tank (cubic feet), using the level instrument for assigned tank:
                (a) Sludge holding tank 1: SHF-SLB1-LIT-01.
                (b) Sludge holding tank 2: DIG-SLB1-LIT-01.
            (2) X = Operator adjustable value (0-100 scfm/1000 ft3). Default values for two modes:
                (a) Full air: 30 scfm/1000 ft3.
                (b) Minimum air: 10 scfm/1000 ft3.
            (3) Blower 2 will serve both sludge holding tank number 1 and sludge holding tank number 2. The Air Flow Rate Setpoint will be calculated utilizing the sludge volume of the tank assigned to the blower.
        b) The SCADA PLC will adjust the speed of the blower, so the airflow rate measured by the thermal mass flowmeter (Y-AIPI1-FIT-01 or Y-AIPI1-FIT-02) matches the calculated airflow rate (Q) for the corresponding sludge holding tank.
        c) The deadband shall be an operator adjustable value (0-200 scfm, default 50 scfm).
        d) Minimum blower speed allowed shall be coordinated with the blower and VFD supplier.
    2) Shutdown Level setpoint in feet (operator adjustable 0-15 feet, default 3 feet).
    3) To prevent diffuser fouling, do not turn off airflow.
8. Failure modes:
    a. VFD Failure: In the case of a VFD failure, the VFD can be bypassed and the blower can be run at full speed.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

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SECTION 17200

INSTRUMENTATION AND CONTROL CABINETS AND ASSOCIATED EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Furnish, install, and put into satisfactory service Main Instrumentation/Control Panels “AD-CONTROLPANEL-01”, “AD-CONTROLPANEL-02”, “AD-CONTROLPANEL-03”, “SUB1-CONTROLPANEL-01”, “SUB1-CONTROLPANEL-02” and “SUB1-CONTROLPANEL-03” as specified herein and as shown on the PLANS.

B. Furnish, install, and put into satisfactory service the modifications to the Owner’s existing Instrumentation/Control Panels “OP-MCP-001” as specified herein and as shown on the PLANS.

C. Furnish, install, and put into satisfactory service Local Control Panels located at the Aeration Basins, the Influent Lift Station, the Plant Drain Pump Station and the Scum Pump Stations as specified herein and as shown on the PLANS.

D. The requirements of this Section of the Specifications apply to all of the various types of instrumentation and control cabinets/boxes as specified herein and shown on the PLANS.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR’s Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit the following in accordance with the Section 01300 and 01730 of the Specifications:
   1. Shop drawings and product data. Include paint color selection chart for selection of paint color by OWNER.
   2. Operation and maintenance manuals.

1.04 TOOLS AND SPARE PARTS

A. Furnish the following spare parts in conformance with the specifications:
   1. One set (minimum 3) of fuses for each type and size used.
   2. One set (minimum 3) of Circuit Breaker Overcurrent Protection Devices for each type and size used.
   3. Twenty (20) terminal blocks of each color and type used.
   4. Four (4) control relay assemblies of each type specified, complete with all accessories.
   5. Four (4) timing relay assemblies of each type specified, complete with all accessories.
   6. Two (2) complete Instrument Loop Current Isolators (I/I converters) for each type specified.
   7. Two (2) complete Programmable Pump Controllers, complete with all accessories.
   8. 25 percent spare push-buttons, selector switches, indication light assemblies for each type used (minimum of 2 per type).
   9. 50 percent of spare lenses and lamps for each type, color and size used (minimum of 4 per type)
   10. Two (2) sets of filter media for each exhaust fan with filtered louvers.

PART 2 PRODUCTS

2.01 INSTRUMENT AND CONTROL CABINETS/PANELS

A. General:
   1. The various instrument and control cabinets/panels shall be constructed to the approximate dimensions and instrument arrangement as shown on the PLANS. The ENGINEER will review alternate arrangements and recommendations.
   2. Hinges and doors shall be capable of supporting weight of equipment mounted on doors.
   3. Mounting channels and interior panels shall be provided in the cabinets for mounting terminals, relays, etc.
   4. The cabinet shall be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located in the panel.
   5. Furnish and install both isolated and non-isolated ground bars for each cabinet. Furnish and install for each ground bus:
      a. Required number of terminals for proper wiring in addition to 20 percent spare terminals for future connections
      b. Isolated Ground Bus Only: 600 volt mounting isolators.
      c. Certain microprocessor based control equipment (e.g. PLCs, etc.) will require the connection of both distorted and undistorted (isolated) ground wires. Provide this wiring as required.

B. Freestanding Cabinets/Panels:
   1. Type: Free Standing, modular design, completely enclosed
   2. Configuration: Provide Single Bay and Double Bay as required. Use Double-Bay where possible. Each Single Bay section shall have one door, and each

Double-Bay section shall have two doors, unless specifically shown otherwise on the PLANS. Provide sections with rear doors where specifically shown on the PLANS.

3. Enclosure Material: Steel
4. Framing Member Thickness: 12 gauge, minimum
5. Door/panel member Thickness: 14 gauge, minimum.
6. Rating: NEMA-12 gasketed
7. Finish: Prime and paint using manufacturer's standard process.
8. Finish color: For Contract Bidding purposes, Foxboro beige with textured finish. The final exterior cabinet components color shall be selected by the OWNER after Contract Bid Award.
9. Interior Panel Finish Color: All interior back and side panels shall be factory painted white.
10. Additional Requirements for each Door:
    a. Solid, Gasketed, and Hinged
    b. 3-point latching mechanism, door latch rods shall have rollers.
    c. Oil-tight key-locking handle.
    d. Reinforcing bars for inner device panels
    e. Data pocket,
    f. Door stop kit
    g. Thermostatically controlled exhaust fan complete with filtered louver. Fan rated for 120 volts A. C. Connect as shown on the PLANS. Refer to the PLANS. Exception: fans and louvers are not required for rear doors.
    h. Air intake/exhaust louver. Refer to the PLANS.
    i. Electrically bonded to the frame using manufacturer's grounding device assembly and #8 AWG green insulated ground wire.
11. Comply with the requirements of the PLANS.
12. Miscellaneous Accessories:
    a. Provide each section with 7.5-inch high solid plinth base. Include solid base access panel covers.
    b. Provide 1-1/2 inches high removable heavy-duty fiberglass floor grating at the bottom of each section (above the plinth base). The floor grating shall meet OSHA safety standards for personnel traffic. Wiring routed underneath grating shall be neatly laced/arranged.
    c. Include all back, joining, side, hinged swing-out, etc. panels, slide-out shelves, 19" rack mounting brackets, all associated mounting hardware to facilitate a complete installation and a totally enclosed overall cabinet. Also refer to the PLANS. All panels shall be full height unless specifically shown otherwise on the PLANS.
    d. Removable lifting eyes
    e. Panel stabilizers and extra support brackets where conduit connects to the enclosures.
    f. Cabinet manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation.
    g. Provide overall master nameplate for the cabinet, as hereinafter specified, with the exception that the text height shall be 3/8 inch.
13. The cabinets shall be as manufactured by "HOFFMAN" Model PROLINE Modular Industrial Enclosures complete with specified accessories, or approved equal by "RITTAL"

C. Wall/Rack Mounted Cabinets/Panels
   1. General:
      a. Enclosure shall be equipped with hinged doors complete with 1/4 (quarter) turn door latches. Provide door latch handle. Furnish and install pad locking means for the door/handle.
      b. Each enclosure door assembly shall be furnished with manufacturer's door stop kit that will hold the door open in any position between 0-130 degrees. Each door shall be electrically bonded to the frame of the associated enclosure with #8 AWG 600 volts insulated green ground wire. Utilize manufacturer's grounding device assembly. The inside of each door shall be equipped with the manufacturer's data-pocket for storing drawings and manuals.
      c. Each enclosure shall be furnished with a full and solid backpanel (one piece full subpanel). The backpanel shall extend the full height and width of the cabinet/panel. The backpanel shall be factory painted white.
      d. Cabinet/Panel manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation. Adherence to this requirement is necessary in order to accomplish a good craftsmanship-like system installation to the satisfaction of the Owner and Engineer.
      e. Each enclosure shall be as manufactured by "Hoffman" model Concept series industrial enclosures complete with specified accessories, or approved equal by "Rittal".
      f. The minimum anticipated panel size for each wall/rack mounted cabinet/panel is shown on the PLANS. The Contractor shall size each cabinet/panel per the requirements of the NEC. Contractor to determine exact as-built size required for the cabinet/panel to meet the contract documents (drawings and specifications) without any additional cost to the Owner (should the final size be larger than that which was anticipated by the PLANS). Additionally, the Contractor is to carefully review the electrical/control floor plan drawing and make any adjustments/equipment rearrangements necessary to meet National Electrical Code requirements and any other safety codes adopted by the City of Austin should the cabinet/panel size be any greater/larger than the minimum size required by the PLANS. Conduit/wiring, etc. adjustment caused by any equipment rearrangement, etc. shall also be provided at no additional cost to the Owner.
   2. Enclosures installed indoors inside the environmentally and climate controlled ELECTRICAL ROOMS:
      a. Each enclosure shall be NEMA-12 dustight/oiltight with ANSI No. 61 Gray finish.
   3. Enclosures installed indoors inside STORAGE ROOMS and PROCESS MECHANICAL EQUIPMENT ROOMS and installed in ALL OUTDOOR AREAS:
      a. Each enclosure shall be 316 stainless steel NEMA 4X.
   4. Additional devices are required to be installed inside of each proposed Lighting Contactor Control Panel that are not described in this Section of the Specifications. Furnish and install these devices as required by the PLANS. Refer to the PLANS.
   5. Where Ethernet switches and/or copper patch panels are shown on the PLANS to be installed within Cabinets/Panels, 3-inch or 4-inch plastic wireway

shall surround the switches and patch panels for cable management inside the enclosure. Refer to the requirements of plastic wireway in this Section of the Specifications.

D. Free Standing Server Computer Cabinet/Panel:
   1. Type: Free Standing, modular design, completely enclosed except that the doors shall be perforated as described hereinafter. Interior frame members shall be pre-drilled for mounting devices in accordance with EIA standards.
   2. Configuration: Provide Single Bay as required. Each Single Bay section shall have one front door and two rear doors, unless specifically shown otherwise on the PLANS.
   3. Enclosure Material: Steel
   4. Static Load Rating: 2500 pounds
   5. Finish: Prime and paint using manufacturer's standard process.
   6. Finish color: Manufacturer's standard
   7. Additional Requirements for each Door:
      a. 80 percent perforated and Hinged
      b. latching mechanism
      c. key-locking handle.
      d. Door stop kit
      e. Thermostatically controlled exhaust fan complete with filtered louver. Fan rated for 120 volts A. C. Connect as shown on the PLANS. Refer to the PLANS.
      f. Electrically bonded to the frame using manufacturer's grounding device assembly and #8 AWG green insulated ground wire.
   8. Comply with the requirements of the PLANS.
   9. Miscellaneous Accessories:
      a. Each enclosure shall have field adjustable leveling feet
      b. Stabilizer bars for floor mounting
      c. Mounting hardware to secure to adjacent modular enclosures
      d. Provide 1-1/2 inches high removable heavy duty fiberglass floor grating at the bottom of each section. The floor grating shall meet OSHA safety standards for personnel traffic. Wiring routed underneath grating shall be neatly laced/arranged.
      e. Include all joining, side, etc. panels, rack mounting brackets, filler panels, all associated mounting hardware to facilitate a complete installation. Also refer to the PLANS. All panels shall be full height unless specifically shown otherwise on the PLANS.
      f. Panel stabilizers and extra support brackets where conduit connects to the enclosures.
      g. Cabinet manufacturer's additional hardware and component accessories shall also be provided that will result in a neat, safe, aesthetically pleasing installation.
      h. Provide overall master nameplate for the cabinet, as hereinafter specified, with the exception that the text height shall be 3/8 inch.
      i. 120VAC outlet strips:
         1) Cabinet Mounted Multi-Outlet Power Strip: Multi-Outlet Power Strip shall have a total of 7, 120 volt NEMA 5-15R receptacles, U.L. Listed, horizontal rack mount. Furnish and install model DM07RM-20, 120VAC, 16A as manufactured by Dell. Furnish all hardware as required so as to mount power strip onto the server cabinet.

2) Furnish and install two (2) Server Cabinet Mounted Multi-Outlet Power Strip for each server cabinet, with each Multi-Outlet Power Strip served by a dedicated circuit breaker.
3) Furnish and install two (2) convenience receptacles at the rear of the cabinet, with each receptacle connected to a dedicated 20A circuit breaker. Refer to the requirements of convenience receptacle in this section of the specifications. Tag each duplex receptacle with "White-Black-White" laminated phenolic material having engraved letters approximately 1/4 inch high of the tag of panel board and circuit number serving the receptacle.

10. Cabinet/Panel shall be as manufactured by "DELL" PowerEdge 4820D 48U Server Rack or approved equal by Tripp Lite.

E. Free Standing Network Switch Cabinet/Panel:
1. Type: Free Standing, modular design, completely enclosed except that the doors shall be perforated as described hereinafter. Interior frame members shall be pre-drilled for mounting devices in accordance with EIA standards.
2. Configuration: Provide Single Bay as required. Each Single Bay section shall have one front door and two rear doors, unless specifically shown otherwise on the PLANS.
3. Enclosure Material: Steel
4. Static Load Rating: 2500 pounds
5. Finish: Prime and paint using manufacturer's standard process.
6. Finish color: Manufacturer's standard
7. Additional Requirements:
   a. Front Door:
      1) Single Front door with keyed multi-point vault-style latch system and central key lock to ensure security
      2) Rigid front door made of aluminum extrusions and formed perforated steel, with more than 70 percent open space for free flow of cool air to equipment
   b. Split overlapping perforated rear doors
   c. Front vertical cable management with integral hinged doors to house, protect patch cabling
   d. Front cable management with arrowhead support fingers to support and ensure proper bend radius
   e. Side panel on all exposed sides of the cabinet
   f. Open base to allow bottom cable entry
   g. Rear horizontal and vertical cable management
   h. Furnish and install additional horizontal and vertical cable management:
      1) At minimum, furnish horizontal cable management above and below the front of each patch panel and each switch.
   i. 120VAC outlet strips:
      1) Cabinet Mounted Multi-Outlet Power Strip: Multi-Outlet Power Strip shall have a total of 7, 120 volt NEMA 5-15R receptacles, U.L. Listed, horizontal rack mount. Furnish and install model DM07RM-20, 120VAC, 16A as manufactured by Dell. Furnish all hardware as required so as to mount power strip onto the cabinet.
      2) Furnish and install two (2) Cabinet Mounted Multi-Outlet Power Strip for each cabinet, with each Multi-Outlet Power Strip served by a dedicated circuit breaker.

3) Furnish and install two (2) convenience receptacles at the rear of the cabinet, with each receptacle connected to a dedicated 20A circuit breaker. Refer to the requirements of convenience receptacle in this section of the specifications. Tag each duplex receptacle with "White-Black-White" laminated phenolic material having engraved letters approximately 1/4 inch high of the tag of panel board and circuit number serving the receptacle.

8. Comply with the requirements of the PLANS.
9. Cabinet/Panel shall be as manufactured by "Hoffman" proline network switch cabinet, 6509/6513 series, 48U cabinet, minimum 47" depth.

2.02 INSTRUMENT AND CONTROL WIRING

A. General wiring and control power and alarm wiring:

1. Extra flexible, #14 AWG, tin plated copper conductor 600V insulation, SIS wire manufactured by General Cable Company, The Okonite Company or approved equal. The pigmentation of the wire insulation shall conform to the color table listed below:

Wiring Function	Wire Jacket Color
Wiring for 120 volts A.C. control/status signal wiring. This does not apply to control/status signal wiring that are scheduled for interface with Programmable Logic Controller (PLC) and Alarm wiring	Red
Wiring for 120 volts A.C. control to relay coils (L1 & L2 terminals or H&N terminals) that are not generated from a PLC Discrete Output point (DO)	Gray
Wiring for 120 volts A.C. power to instrumentation and control devices that are not generated from a PLC Discrete Output point (DO)	Gray
Alarm wiring	Yellow
Wiring for 24 volts D.C. power supply wiring	Blue = Positive Brown = Negative
Wiring for 120 volts A.C. light fixtures, convenience receptacles and exhaust fans	Red = Line (Phase A) Black = Line (Phase B) Blue = Line (Phase C) White = Neutral
Wiring to Discrete Input PLC modules	Violet
Wiring to Discrete Output PLC modules	Pink

Wiring Function	Wire Jacket Color
Ground wires	Green

B. 4-20 Milliamp Signal wiring:
   1. Number of Pairs: One
   2. Wire Size: #16 AWG
   3. Type of Conductors: Stranded copper conductors, twisted
   4. Individual Conductor Insulation: PVC
   5. Individual Conductor Insulation Color: Positive (+) is Black, Negative (-) is White
   6. Drain Wire: Tinned copper
   7. Overall Shield: Aluminum-mylar shield.
   8. Overall Jacket: PVC
   9. Overall Jack Color: Black.
   10. Manufacturer: Samuel Moore and Company, Dekoron Division, Cat. No. 1852 or approved equal.

C. Multi-Conductor RTD Temperature Signal Wiring:
   1. Number of Triads: One
   2. Wire Size: #16 AWG
   3. Type of Conductors: Stranded copper conductors, twisted
   4. Individual Conductor Insulation: PVC
   5. Individual Conductor Insulation Color: Positive (+) is Black, Negative (-) is White, Sense (S) is Red.
   6. Drain Wire: Tinned copper
   7. Overall Shield: Aluminum-mylar shield.
   8. Overall Jacket: PVC
   9. Overall Jack Color: Black.
   10. Manufacturer: Samuel Moore and Company, Dekoron Division, Cat. No. 1862 or approved equal.

D. RS-232 ModBus Digital Data Communication System Wiring:
   1. Number of Pairs: Two
   2. Wire Size: #22 AWG
   3. Type of Conductors: Tinned stranded copper conductors, twisted
   4. Individual Conductor Insulation: 300 volt PVC
   5. Individual Conductor Insulation Color: Red, Black, Green, and White.
   6. Drain Wire: No. 24 AWG Tinned copper
   7. Overall Shield: Aluminum-mylar shield.
   8. Overall Jacket: PVC
   9. Overall Jacket Color: Chrome.
   10. Manufacturer: Belden, Catalog No. 8723, or approved equal.

E. RS-485 Digital Data Communication Cable System Wiring:
   1. Number of Pairs: One
   2. Wire Size: #22 AWG
   3. Type of Conductors: Tinned stranded copper conductors, twisted
   4. Individual Conductor Insulation: 300 volt PVC
   5. Individual Conductor Insulation Color: White/Blue Stripe & Blue/White Stripe.

6. Overall Shield: Aluminum-mylar shield and tinned copper braid.
7. Overall Jacket: PVC
8. Overall Jacket Color: Black.
9. Manufacturer: Belden, Catalog No. 3105A, or approved equal.

F. Ethernet Data Communication Wiring:
1. Number of Pairs: Four
2. Wire Size: #23 AWG
3. Type of Conductors: solid copper conductors, twisted
4. Individual Conductor Insulation: 300 volt polyolefin
5. Individual Conductor Insulation Color: White/Blue Stripe, Blue, White/Orange Stripe, Orange, White/Green Stripe, Green, White/Brown Stripe, Brown
6. Drain Wire: No. 24 AWG Tinned copper
7. Overall Shield: unshielded
8. Overall Jacket: PVC, include ripcord
9. Overall Jacket Color: Blue
10. Maximum Attenuation at 100 MHz: 18.9 dB per 100 meters of cable length
11. Maximum Attenuation at 250 MHz: 31.2 dB per 100 meters of cable length
12. Agency Compliance: ANSI/TIA/EIA-568 B.2-1 Category 6
13. Manufacturer: Belden, Catalog No. 7851A, or approved equal.

G. Fiber Optic Cable:
1. Refer to Section 17600 Distributed Control System.

2.03 INSTRUMENT AND CONTROL CABINETS EQUIPMENT

A. Overcurrent Protection
1. General: Individually protect each device as shown on the PLANS. Furnish and install protection using the devices shown on the PLANS and as specified hereinafter.
2. 120 volts AC circuit Protective Devices:
a. Ratings: 120 volts A. C., one pole. Size per NEC. Note: Use 20 ampere rating for control panel convenience receptacles.
b. Certifications: U. L. Listed.
c. Mounting: Din Rail Mountable
d. Indications: Visible trip indicator
e. Manufacturer: Allen-Bradley Series 1492-SP, Phoenix Contact, or approved equal.
3. 24 volts DC circuit breakers:
a. Ratings: 24 volts DC, one pole. Size per NEC.
b. Certifications: U. L. Listed
c. Mounting: DIN rail mountable
d. Indications: Visible trip indicator
e. Manufacturer: Allen-Bradley Series 1492-GH, Phoenix Contact, or approved equal.

B. Convenience Receptacle:
1. Furnish and install where required by the PLANS. Additional receptacle assembly features are as follows:
a. Specification grade
b. Duplex, 3-wire, polarized grounding type, rated 20 amp, 125 volt, 60 Hertz

c. Ivory Color
d. Manufacturer: Hubbell No. HBL5362I, Bryant**,** Pass and Seymour, or approved equal.
e. Coverplate: 304 brushed stainless steel, as manufactured by Hubbell, Killark, or approved equal.
f. Install in NEMA-1 enclosure inside of the control panel.

C. Lighting Fixture:
1. Furnish and install where required by the PLANS. Additional light fixture features are as follows:
a. Type: LED
b. Voltage: 120 volts A.C
c. Length: 14 inches
d. Lumens per fixture: 400 lumens
e. Although it may not be shown on the PLANS, furnish and install two light fixtures per vertical section of control panel enclosure
f. Motion sensors shall not be accepted.
g. Furnish and install manufacturer's extension cable to connect to fixture.
h. Furnish and install door switch wired to switch the light based upon door position

D. Pushbuttons, Selector Switches, Pilot Lights
1. General Requirements:
a. Rating: NEMA 4/13 Watertight/Oiltight, Heavy Duty
b. Size: NEMA Style full size 30-millimeter (30mm),
c. Contacts: 10 ampere minimum at 120 volts A.C. Provide number of contacts to satisfy the requirements of the PLANS.
d. Legend Plate: Furnish and install per manufacturer's standard with inscription as shown on the PLANS.
e. Manufacturer: Allen Bradley Bulletin 800T, or approved equal.
2. Additional Requirements for Selector Switch/ Pushbuttons:
a. Operator Color: Furnish and install the color as shown on the PLANS, black otherwise.
b. Selector Switch Action Type: Maintained action, unless shown otherwise on the PLANS.
c. Pushbutton Action Type: Momentary action, unless shown otherwise on the PLANS.
d. Furnish one Normally Open and one Normally Closed contact block over the quantity shown on the PLANS for each selector switch and pushbutton.
3. Additional Requirements for Pilot Lights:
a. Type: Transformer Type Light Emitting Diode (LED),
b. Style: Push-to-test
c. Lens Color: Furnish and install the colors as shown on the PLANS.
4. Additional requirements for Emergency Stop/Trip Push-Button Stations:
a. Action Type: Push-Pull maintained
b. Operator Type: Mushroom head
c. Operator Color: Red, unless shown otherwise on the PLANS
d. Padlock attachment: Furnish and install as manufactured by Allen-Bradley Bulletin Push-Pull Padlocking Attachment Catalog Number 800T-N314, or approved equal.

e. Padlock: Furnish and install padlock with 0.25 inch diameter padlock shackle. Coordinate the shackle diameter with the padlock attachment. Furnish and install padlock as manufactured by Master Lock, or approved equal.

E. Control Relays: Control relays shall be furnished and installed as required by the schematic diagrams. All control relays shall be Type I relays unless specifically noted otherwise on the PLANS or as specified hereinafter.

1. Type I Control Relays:
   a. Type: 600 volt Heavy-Duty industrial type
   b. Rated: NEMA rated
   c. Coil Voltage: 120 volts A.C.
   d. Contact Rating: 10 ampere at 120 volts A.C.
   e. Number and Configuration of Contacts: 4 Normally Open and 4 Normally Closed, at minimum. Furnish and install one additional normally open (N.O.) and one additional normally closed (N.C.) contact, over that required by the PLANS. Field configurable type contacts.
      1) Should the requirements of the PLANS and the required spare contacts surpass the number and configuration of contacts specified herein, furnish and install additional Type I control relay(s) connected in parallel to provide the required quantity of contacts.
   f. Position Indication: Visual mechanical unlatch-latch indicator
   g. Mounting: Provide universal mounting strip/plate for backpanel mounting.
   h. Accessories: Relay Manufacturer's Transient Voltage Suppression Module
   i. Manufacturer: Allen Bradley Bulletin 700-P, or approved equal.
   j. The following are additional requirements associated with Type I control relays:
      1) Of the maximum of eight contacts that are available from each Type I Control Relay, one of the Form-C contacts shall be dedicated as "spare" and wired to terminal blocks for future use by the OWNER. Multiple Type II relay coils shall not be connected in parallel in order to develop additional contacts as may be shown on the PLANS. Should the PLANS require greater than two contacts from a control relay, then furnish and install a Type I Control Relay in lieu of a Type II Control Relay.
2. Type II Control Relays:
   a. Type: 300 volt "Ice-Cube" type
   b. Rated: Pilot-Duty C300 rated
   c. Coil Voltage: 120 volts A.C.
   d. Contact Rating: 10 ampere at 120 volts A.C.
   e. Number and Configuration of Contacts: three Form-C Contacts (3PDT)
   f. Position Indication: Integral LED pilot light
   g. Manual Operator: Integral to relay
   h. Mounting: DIN rail mountable socket
   i. Accessories: Socket, Retaining Clip, Relay Manufacturer's Transient Voltage Suppression Module.
   j. Manufacturer: "Allen-Bradley" Bulletin 700-HA33A1-3-4, complete with 700-HN205 socket, 700-AV3R surge suppressor, and 700-HN157 retainer clip, or approved equal.

k. The following are additional requirements associated with Type I control relays:
    1) Of the maximum of three Form-C type contacts that are available from each Type II Control Relay, one of the Form-C contacts shall be dedicated as “spare” and wired to terminal blocks for future use by the OWNER. Multiple Type II relay coils shall not be connected in parallel in order to develop additional contacts as may be shown on the PLANS. Should the PLANS require greater than two contacts from a control relay, then furnish and install a Type I Control Relay in lieu of a Type II Control Relay.

3. Type III Control Relays:
    a. Type: 300 volt “Ice-Cube” type
    b. Coil Voltage: 24 volts D.C. (nominal voltage)
    c. Position Indication: Integral LED pilot light
    d. Manual Operator: Integral to relay
    e. Contact Rating: 10 ampere at 120 volts A.C.
    f. Number and Configuration of Contacts: four (4) Form-C Contacts (4PDT)
    g. Mounting: DIN rail mountable socket
    h. Accessories: LED indicator light, Push-to-Test button, Socket and retaining clip, relay manufacturer’s Transient Voltage Suppression Module.
    i. Miscellaneous: Used only where specifically noted on the DRAWINGS.
    j. Manufacturer: "Allen-Bradley", catalog 700-HF34Z24-3-4, complete with relay socket base catalog number 700-HN264, relay retaining clip 700-HN266 and suppression module 700-AR1, or approved equal.
4. Type IV Control Relays:
    a. Type: 600 volt Heavy-Duty industrial type, mechanically held latching relay with separate “set” and “reset” coils.
    b. Rated: NEMA rated
    c. Coil Voltage: 120 volts A.C.
    d. Contact Rating: 20 ampere at 120 volts A.C., rated for lighting type loads
    e. Number and Configuration of Contacts: 3 Normally Open, at minimum. Furnish and install one additional normally open (N.O.), over that required by the PLANS.
    f. Position Indication: Visual mechanical unlatch-latch indicator
    g. Mounting: Provide universal mounting strip/plate for backpanel mounting.
    h. Accessories: Relay Manufacturer’s Transient Voltage Suppression Module
    i. Manufacturer: Allen Bradley Bulletin 700-PK, or approved equal.
5. Type V Control Relays:
    a. Type: 300 volt “Ice-Cube” type
    b. Coil Voltage: 24 volts A.C. (nominal voltage)
    c. Position Indication: Integral LED pilot light
    d. Manual Operator: Integral to relay
    e. Contact Rating: 12 ampere at 120 volts A.C.
    f. Number and Configuration of Contacts: four (4) Form-C Contacts (4PDT)
    g. Mounting: DIN rail mountable socket
    h. Accessories: LED indicator light, Push-to-Test button, socket and retaining clip, relay manufacturer’s Transient Voltage Suppression Module.
    i. Miscellaneous: Used only where specifically noted on the DRAWINGS.

j. Manufacturer: "Allen-Bradley", catalog 700-HF34A24-3-4, complete with relay socket base catalog number 700-HN264 and relay retaining clip 700-HN266 and surge suppression model 700-AR1, or approved equal.

F. Timing Relays:
1. Type: Solid state, multi-time, and multi-function type relay. Both timing ranges and timing modes shall be field selectable. Each relay shall be capable of the following timing modes: On Delay, Off Delay, One Shot, Repeat Cycle, and Interval
2. Coil Voltage: 120 volts A. C.
3. Contact Rating: 10 amps, continuous, at 120 VAC.
4. Number and Configuration of Contacts: 2 Form C (2PDT)
5. Mounting: DIN rail mountable socket
6. Accessories: Socket, DIN rail mountable
7. Manufacturer: Square D Class 9050 model No. JCK70 complete with Type NR61 Socket, or approved equal.

G. Alternator Relay:
1. Type: Microprocessor based, sequence on, simultaneous off type two load alternator relay. Field selectable switch for alternator function or individual lead selection. LED indicators for stop, lead, and lag discrete inputs as well as load contact outputs.
2. Coil Voltage: 120 volts A. C.
3. Contact Rating: 10 amps, continuous, at 120 VAC.
4. Number and Configuration of Contacts: 2 Form A (SPST)
5. Mounting: DIN rail mountable socket
6. Accessories: Socket, DIN rail mountable
7. Manufacturer: Time-Mark model No. 2611 complete with Model 51X120 Socket, or approved equal

H. Speed Control Potentiometer Transmitters:
1. Input: 3-wire potentiometer ranging from 0-100 ohms through 0-10,000 ohms.
2. Output: 2-wire loop powered, 4-20mA signal proportional to the percent (%) travel of the potentiometer (input signal).
3. Adjustments: Twenty-two turn potentiometers
a. Span: 0-100 percent adjustable over selected input range of 15%-100% of potentiometer value.
b. Calibration Capability: +/- 0.1% of full span (linearity and repeatability).
4. Ambient Temperature: -20°F to +180°F
5. Housing: High-density type, DIN-rail mount
6. Range: Verify with manufacturer of Potentiometers and/or manufacturer of the Adjustable Speed Drive units (ASD) prior to ordering the transmitters.
7. Accessories:
a. Front accessible terminal blocks
b. RFI filter terminal assembly
8. Identification: Tag by loop number and loop process identification. Refer also to the PLANS.
9. Manufacturer: MOORE Industries Model PTX with specified accessories, or approved equal.

I. Single Input, Dual Output Instrument Loop Current Isolators (I/I Converters)

1. Number and Type of Input Signals: One 4-20mA input signal
2. Number and Type of Output Signals: Two 4-20 mA isolated output signals. Integral load trimmer.
3. Maximum Load: 1200 Ohms per output channel.
4. Power Requirements: External 24 VDC supply as also shown on the PLANS.
5. Accuracy: +/- 0.1% of full span
6. Housing: Corrosion resistant metal
7. Mounting: DIN rail mountable.
8. Noise Protection: Provide RFI /EMI protection such that less than +/- 0.1 % of span error is incurred when tested against a reference signal of 30 volts per meter over the frequency range of 20 to 1000 MHz, inclusive.
9. Transmitter Excitation: Provide with field selectable transmitter excitation option which allows the isolator to supply 24VDC power to a 2-wire instrument connected to the isolator input.
10. Manufacturer: MOORE Industries Model ECT-DIN with TX, or approved equal.

J. Single Input, Single Output Instrument Loop Current Isolators (I/I Converters)
1. Number and Type of Input Signals: One 4-20mA
2. Number and Type of Output Signals: One 4-20mA. Integral load trimmer
3. Maximum Load: 1000 Ohms
4. Power Requirements: External 24 VDC supply as also shown on the PLANS.
5. Accuracy: +/- 0.1% of full span
6. Housing: Corrosion resistant metal
7. Mounting: DIN rail mountable
8. Noise Protection: Provide RFI/EMI protection such that less than +/- 0.1 % of span error is incurred when tested against a reference signal of 30 volts per meter over the frequency range of 20 to 1000 MHz, inclusive.
9. Transmitter Excitation: Provide with field selectable transmitter excitation option which allows the isolator to supply 24VDC power to a 2-wire instrument connected to the isolator input.
10. Manufacturer: MOORE Industries Model ECT-DIN with TX option, or approved equal

K. Programmable Pump Controller (Instrument Set Point Controller)
1. General: Field programmable pump controller with integral front display and programming buttons.
2. Display: Six (6) LED, fourteen (14) segment alphanumeric characters
3. Input signals: 0-20mA, 4-20mA, 0-5V, 0-10V, or -10-10V selected from keypad
4. Output signal: 4-20mA analog retransmission
5. Alarm points:
    a. Four (4) independently set, trip and reset points
    b. Latching or non-latching, selected from keypad
    c. Contacts: SPDT (form C) relays rated 7.5 amps at 240 VAC / 24 VDC
    d. Audible alarm configurable for each channel
    e. Front panel flashing display
6. Performance:
    a. Accuracy: ±0.01% of input range
    b. A/D resolution: 20 bits
    c. Display resolution: +9999 to -1999 in count steps

d. Common mode rejection: Greater than 120 dB at 50/60 Hz
e. Normal mode rejection: Greater than 64 dB at 50/60 Hz
f. Operating temperature: 32° to 158° Fahrenheit

7. Power: 120 VAC
8. Housing:
   a. Aluminum body
   b. Splash proof front panel
9. Mounting: Panel mountable on the face of the instrumentation and control cabinet door
10. Menu Access Security: Six (6) digit, user selectable, password to enter configuration menu
11. Manufacturer: Devar, Inc. Model 3020 with specified options, or approved equal.

L. Instrument Control Panels/Cabinets Single Input Single Output 24VDC Instrument Loop Power Supply:
1. Number of inputs and voltage: One, 120 volts A.C.
2. Number of outputs and voltage: One, 24 volts D.C.
3. Type: Suitable for use as a single stand-alone power supply as well as parallel operation in conjunction with a second power supply and a redundancy/switchover module. Field selectable switch for single or parallel operation.
4. Topology: Switching type power supply
5. Output Current, per unit: 20 ampere
6. Output Voltage Adjustment Range: 22 to 28.5 VDC, field adjustable
7. Output Voltage Ripple: 50 milliVolts at full load, measured peak-to-peak, maximum
8. Output load regulation: 2% maximum from zero to full load.
9. Output Protection: Integral current limiting and over voltage
10. Common Alarm Contact Ratings: 2 ampere at 240 volts A.C.
11. Mounting: Provide DIN rail mounting configuration.
12. Accessories:
    a. Ventilated metal case.
13. Manufacturer: Sola/Hevi-Duty Model SDN 20-24-100P, or approved equal.

M. Instrument Control Panels/Cabinets 24 VDC Power Supply Redundancy/Switchover Module:
1. Number of inputs and voltage: Two, 24 volts D.C.
2. Number of outputs and voltage: One, 24 volts D.C.
3. Type: Unit shall have the capability to immediately and automatically transfer load from the primary to the backup (secondary) power supply unit, as also shown on the PLANS.
4. Topology: Switching type power supply.
5. Output Current, per unit: 40 ampere
6. Vout Alarm Contact Ratings: 2 ampere at 240 volts A.C.
7. Vin Alarm Contact Ratings (2 contacts, one for each input): 2 ampere at 240 volts A.C.
8. Mounting: Provide DIN rail mounting configuration.
9. Accessories:
   a. Ventilated metal case

b. Green light emitting diode (LED) to indicate output voltage exceeds 18 volts D.C.

10. Manufacturer: Sola/Hevi-Duty Model SDN 30/40RED, or approved equal.

N. Control Power Transformer:
1. Size: 300 VA
2. Primary Voltage: 120 VAC
3. Secondary Voltage: 24 VAC
4. Windings: Copper
5. Epoxy encapsulated to protect cores and coils against moisture and contaminants.
6. Integrally molded, flame retardant terminal blocks
7. Heavy gauge steel mounting plate
8. Accessories:
   a. Primary and secondary fuse holders with finger safe covers
9. Manufacturer: SOLA/Hevi-Duty SBE Encapsulated Series with specified accessories, or approved equal.

O. Thermostat:
1. Type: Heavy Duty line voltage type, suitable for use in controlling heating and cooling circuits. Shall have field adjustable temperature setpoint and also display the measured ambient temperature.
2. Measurement Range:
   a. Thermostat: 40 to 90 degrees Fahrenheit
   b. Thermometer: 50 to 90 degrees Fahrenheit
3. Sensing Element: Liquid filled with diaphragm and lever mechanism
4. Thermometer: Bi-metal type
5. Number and Type of Output Contacts: One Single Pole Double Throw (SPDT), snap acting
6. Contact Ratings:
   a. Heating Contact: 16 ampere at 120 Vac.
   b. Cooling Contact: 8 ampere at 120 Vac
7. Enclosure: Thermoplastic cover, suitable for vertical or horizontal mounting configuration
8. Accessories:
   a. Provide temperature adjustment knob
   b. Provide faceplate with each thermostat with temperature measured in degrees Fahrenheit. Faceplate shall include cutout such that the measured ambient temperature is visible.
   c. Mount each thermostat in a device enclosure on the enclosure backpanel in accordance with the manufacturer's recommendations.
9. Manufacturer: Johnson Controls Model T26T Series Line Voltage Thermostat, or approved equal

P. Terminal Blocks:
1. General:
   a. All terminal blocks shall be Type I Terminal Blocks unless noted otherwise in the Specifications or on the PLANS.
   b. All terminal blocks shall be provided with manufacturer's standard snap-in marker card and holder as manufactured by Allen-Bradley Bulletin No. 1492-SMN81, Phoenix Contact, or approved equal. Provide

manufacturer's standard typed adhesive terminal block tag for each terminal block.

c. Provide manufacturer's standard insulating jumpers, DIN rail, barriers, end anchors, etc., and all related mounting hardware as required for a complete and functional installation. Coordinate models of terminal block accessories such as end anchors, jumpers, DIN rail, etc., with the terminal blocks as specified hereinafter for a complete and functional installation.

2. Type I Terminal Blocks
   a. Type: Single Layer
   b. Rating: 600 volts A.C./D.C., 55 ampere
   c. Wire Range: No. 22 through No. 8 AWG
   d. Material: Nylon or polypropylene
   e. Quantity per Foot: 37
   f. Color: As specified hereinafter
   g. Manufacturer: Allen-Bradley Bulletin 1492-HM3, Phoenix Contact, or approved equal.
3. Type II Terminal Blocks
   a. Type: Single Layer, fused terminal blocks
   b. Rating: 300 volts A.C./D.C., 12 ampere
   c. Wire Range: No. 30 through No. 12 AWG
   d. Material: Nylon or polypropylene
   e. Quantity per Foot: 33
   f. Fuse: Bussman ¼ inch x 1-1/4 inch
   g. Miscellaneous: Provide with LED blown fuse indicator
   h. Manufacturer: Allen-Bradley Bulletin 1492-H5, Phoenix Contact, or approved equal.
4. Terminal Block Colors: Provide terminal blocks with the colors as follows:

Terminal Block Function	Terminal Block Color
Terminal Blocks for 120 volts A.C. control/status/alarm/PLC monitoring	Red
Terminal Blocks for 120 volts A.C. power wiring	Black
Terminal Blocks for Ground wiring	Green
Terminal Blocks for 24 volts D.C. wiring	White

Q. Flexible spiral wrapping: Size as required. Provide as manufactured by Electrovert Spiraband, or approved equal.

R. Plastic Wireway: Size as required. Also refer to the PLANS. Provide white color unless specified otherwise. Provide as manufactured by Panduit, or approved equal.

S. Multi-Outlet Power Strip: Furnish and install where shown on the PLANS.
   1. Shelf Mounted: Provide white color unless specified otherwise. Multi-Outlet Power Strip shall have six 15 ampere, 120 volt NEMA 5-15R receptacles, U. L. Listed, main circuit breaker and integral on/off switch and indicator light and integral 4 foot power cord. Furnish and install as manufactured by Kensington Model 50688 or approved equal.

2.04 MANUFACTURER FURNISHED DEVICES

A. Manufacturer furnished control devices that are not described in this Section of the Specifications are required to be installed inside of proposed instrumentation and control cabinets and local control panels as shown on the PLANS. The control devices shall include leakage and temperature alarm and relay control devices for submersible equipment and digital thermo regulator relays/controllers for run dry control for progressing cavity type pumps. Install these devices as required by the PLANS. Refer to the PLANS. Refer also to applicable process mechanical equipment Sections of the Specifications.

2.05 INSTRUMENT CONTROL PANELS/CABINETS UPS:

A. Where required by the PLANS, furnish and install the quantity of Uninterruptible Power Supply (UPS) units in each of the instrument/control/communication cabinets as shown on the PLANS. Each UPS shall be as follows:
   1. The UPS shall have the apparent power rating as shown on the PLANS at minimum.
   2. Each UPS shall operate from 120 VAC input power and shall provide 120 VAC output power. The UPS shall have a capacity to deliver the continuous full load AC output current shown on the PLANS at 120 VAC for fifteen (15) consecutive minutes at minimum, after the input power is removed. The output wave form shall be 60Hz sinusoidal with 5% maximum harmonic distortion. The UPS shall be filtered with 0.3% IEEE surge let-through and zero clamping response time, complying with UL 1449 requirements. The output shall have over current protection with latched shutdown.
   3. The UPS shall consist of a field configurable bypass mode for automatic or manual bypass to the AC input source.
   4. The UPS shall consist of automatic self test, executed on start up and at regular intervals (minimum of once per 14 days), and fault detection LED annunciating self test failure. Upon inverter module failure, the UPS shall automatically direct connect the connected load to the input power source and bypass the inverter module.
   5. The UPS shall consist of automatic voltage regulation to maintain its sine wave output in accordance to these specifications. The settings for the UPS AC input source voltage high and low values to initiate transfer to battery power shall be field adjustable.
   6. The UPS shall have the following front panel indications (LED type) and alphanumeric display:
      a. UPS On Status
      b. Fault
      c. On Battery
      d. Bypass
      e. Battery Replacement Needed
   7. The UPS shall have the following audible alarms:
      a. UPS failure
      b. Battery failure
      c. Power loss to the UPS
   8. The UPS shall have the following front panel mounted push buttons:
      a. Energizing UPS
      b. De-energizing UPS

c. Manual UPS Self test initiation

9. The batteries shall be maintenance-free, fumeless, sealed, leak proof batteries that are accessible for replacement by the OWNER. The batteries shall be rated for use in Computer Rooms (by NFPA and all other Safety Codes). Batteries shall have maximum of five (5) hours to charge to 95 percent capacity. Provide battery extension cabinet where required to obtain a minimum duration runtime of fifteen (15) minutes for the connected load in the event of a power loss and where shown on the PLANS.
10. The UPS shall be provided with a manufacturer's standard external maintenance bypass switch. The external maintenance bypass switch shall be sized such to carry the full load current of the UPS inclusive of inrush current, at minimum. Also refer to the requirements shown on the PLANS. The maintenance bypass switch shall be installed in such a manner that the selector switch is accessible from the front of the control cabinet. Provide any additional accessories necessary to facilitate the installation of the maintenance bypass switch.
11. The UPS and the battery backup units shall be installed in a NEMA-12 enclosures.
12. The UPS shall be able to operate from 0 to 40 degrees C.
13. Accessories:
    a. The UPS shall consist of a relay I/O module which provides 24VDC, 1A rated relay output contacts. At minimum, the card shall consist of a dry contact indicating UPS fault, and a dry contact indicating requirement for Battery Replacement. Wire the UPS fault alarm, the battery replacement alarm, and the UPS in bypass status in series to a 24VDC rated Type III control relay as specified in section 17200. An alarm contact from the 24VDC UPS fail relay shall be wired as a discrete input into the programmable logic controller to indicate a UPS common trouble/fail alarm. Also refer to PLANS for wiring to the UPS relay I/O module.
    b. The UPS shall be provided with all necessary interconnecting cables, connectors, Windows compatible configuration software (if necessary), for a complete and functional installation.
    c. Provide all 19 inch rack mounting brackets, miscellanous mounting hardware to facilitate the mounting shown on the PLANS. Provide for the mounting configuration as shown on the PLANS. Mount UPS within the control cabinet, without obstructing access to components within cabinet. Install UPS in accordance to manufacturers requirements and recommendations, including proper UPS power termination, ventilation, and cooling.
14. The UPS shall have a two (2) year manufacturer's warranty at minimum after the final completion of the project.
15. The UPS shall be as manufactured by Eaton Model 9PX Series UPS with external maintenance bypass switch Eaton HotSwap MBP Model EHBPL****R-PDU1U (where **** is based on UPS rating shown on the PLANS), and Relay Interface Card Eaton Model No. Relay-MS , or approved equal.

2.06 PROGRAMMABLE LOGIC CONTROLLERS “PLCS”, AND ASSOCIATED EQUIPMENT

A. Refer to Specifications Section 17600, “Distributed Control System DCS” of the Specifications.

2.07 IDENTIFICATION

A. Instrument and Control Devices Identification
   1. General:
      a. The device designations shall agree with those shown on the PLANS.
      b. Each device shall be provided with permanent type identifying nameplate.
      c. Nameplates:
         1) Type: 3-ply, 1/8” thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
         2) Color: White-Black-White, unless shown otherwise on the PLANS.
         3) Lettering: 1/4 inch height minimum unless shown otherwise on the PLANS, engraved through the face layer to the melamine middle layer.
         4) Accessories: Provide holes for mechanical fastening.
   2. Devices located on the face of, on the back, or inside of instrument control cabinets/panels:
      a. Devices which penetrate the door shall be provided with two nameplates, one located on face of the door and one located on the rear of the door.
      b. Nameplates located on the panels/cabinets face shall be secured with two Type 316-Stainless Steel screws.
   3. Field mounted control and instrument devices:
      a. Securely hang nameplates from each instrument/control device by a flexible stainless steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).

B. Wire Tag:
   1. Rating: Flame-Retardant,
   2. Style: Heavy-Duty Industrial Grade
   3. Type: Heat Shrinkable type.
   4. Character Height: 1/8 inch.
   5. Maximum Length: 2 inches.
   6. Text Type: Typed with indelible marking process. Handwritten shall not be accepted.
   7. Color: Yellow. Exception: Use White for 120 volts A.C. power circuits to instrument/devices, and branch circuit lighting and convenience receptacle circuits.
   8. Manufacturer: “Raychem type Heavy-Duty Industrial Grade ShrinkMark Heat-Shrinkable Marking Sleeves”, or approved equal. Utilize "Raychem" Portable-Marking-System” complete with wire tag cartridges, or approved equal.

2.08 MISCELLANEOUS

A. Corrosion Resistant and Moisture Repelling Electrical Coating/Spray:
   1. Color: Clear. Coordinate spray color with the Owner. Furnish and install the color requested by the Owner at No Additional Cost to the Owner.
   2. Type: Corrosion resistant and moisture repellant fast drying spray coating sealant
   3. Manufacturer: "3M" 1601 Clear-Color Fast Drying Sealer and Insulator, or approved equal.

PART 3 EXECUTION

3.01 STORAGE

A. Storage: Refer to Section 17100.

3.02 PANEL ASSEMBLY

A. All panel assembly, internal wiring, device installation, tagging, etc. shall be accomplished by the ICS prior to shipment. All wiring shall be connected as shown on PLANS and all systems shall be thoroughly checked out prior to shipment of the panel to the site. Additional requirements are as described below.

B. Termination and Routing of Wiring:
   1. Prior to being connected to any instrument or switch, all incoming wiring shall be terminated to terminal blocks located on an interior panel.
   2. Each PLC shall have dedicated terminal strips for each analog input, analog output, discrete input, and discrete output module, with each point from each module wired out and terminated to terminal blocks i.e., all input/output module points, where shown active or as spare, shall be wired out and terminated to terminal blocks. Spare points shall be treated the same as any other active point and shall follow the same format described under wiring/terminal block tagging scheme/strategy/method. Also refer to and comply with the requirements of the PLANS.
   3. Provide separate terminal blocks for power wiring, from control/discrete signal wiring, and from analog/instrument wiring. Additionally, segregate and isolate analog/instrument terminal strips from control/discrete signal wiring terminal strips from power wiring terminal strips.
   4. Terminate shield wire of each shielded cable to a terminal point (block) on the terminal strip (i.e., treat as current carrying conductor), with each shield terminated to a dedicated terminal block. Extend No. 14 AWG insulated green ground wire from each shielded cable shield termination terminal point to the isolated main ground bar of the cabinet (shield/drain wire ground).
   5. Wire spare contacts of each device (i.e., control relays, timing relays, selector switches, indicating/controlling instruments/devices, etc.) to terminal blocks for future use by the OWNER.
   6. Tag each terminal block. All tags must be typed and neatly attached to the marking surface.
   7. Tag each terminal strip/string of terminal blocks with nameplates as previously specified.

8. Terminal blocks shall have the colors previously specified according to the function of the terminal block.
9. Utilize manufacturer's standard terminal block insulated side jumpers for making connections between adjacent terminal blocks.
10. Route all wiring from a device (instrument, relay contact, push button, etc.) through the terminal block to the other device (instrument, relay contact, push button, etc.) rather than directly from one device to the other.
11. All wiring shall be neatly bundled, laced together and routed as required throughout the cabinet. Enclose wiring routed against the back panel in plastic wireways where possible. Otherwise, group where possible and wrap with flexible wire wrapping or waxed twine. Wiring routed on doors shall be routed such that the door can be fully opened without stressing the wiring.
12. Wire entering the cabinets shall enter through the floor, the side and/or the top of the cabinets via conduits with bushings or hubs.
13. Also refer to and comply with the requirements of the PLANS.

C. Wire Tagging
1. Tag each wire at each end.
2. Tag each wire in multi-conductor cable in addition to the overall cable.
3. Heat shrink all wire tags.
4. Wire Tag Content:
    a. Wiring of each equipment (such as Distribution Service Pump, Pump Discharge Control Valve, etc.) within the facility must be tagged different from any other equipment
    b. Terminal block terminal designation must be included in the wire tag.
    c. To represent all of the text to be shown, multiple wire tags may be needed at each end of the wire. Provide additional tags as necessary at no additional cost to the OWNER.
    d. Provide per Section 16200 "Wiring (600 volt and Below), subsection 3.03 "Wire Tagging Methodology".

D. Special and additional installation requirements associated with fiber optic communication system:
1. The fiber cables entering each cabinet shall be coiled, allowing at least 8-feet of additional cable. The coiled fiber shall be positioned vertically. The fiber bend radius upon entry and coiling must not be less than the minimum required for the cable.
2. The fiber optic cable shall be enclosed in a plastic, flex material. This flex material shall surround the cable for all routing of the cable.

E. After all wiring connections have been made, the Contractor shall apply the Corrosion Resistant and Moisture Repelling Electrical Coating/Spray to all wiring connections. Coordinate application with the Owner. The extent of spray application is further clarified as follows:
1. Spray shall be applied for all terminations of the following types of connections at a minimum:
    a. termination points, terminals, terminal blocks, ground bar, neutral bar/bus,
    b. lugs of circuit breakers, buses, doors, etc.
    c. exposed/stripped ends of each conductor, etc.
    d. bolt-on connections, split-bolt connections, ring lugs, etc.
    e. compression connectors, connector blocks, etc.

f. all other connection types not listed above

2. Spray shall be applied for all terminations at the following types of equipment at a minimum:
   a. Local and main control panels, field instruments, junction boxes, field control stations, control relays, signal isolators, selector switches, pushbuttons, etc.,
   b. Panelboards, transformers, motor control centers, manual motor starters, contactors, light switches, light fixtures, etc.
   c. Motor termination enclosures, valve actuators, cathodic protection system, package control panels of process equipment, etc.
   d. Security system devices, cameras, roadway gate operators, etc.
   e. Convenience receptacles, scada receptacles, etc.
   f. All other types of equipment not listed above.

3.03 FIELD INSTALLATION

A. Install the panels in the locations shown on the PLANS. Also refer to the installation details shown on the PLANS.

B. All wiring shall be connected as shown on PLANS and all systems shall be thoroughly checked out.

C. Install all equipment in accordance with the drawings and instructions furnished by the manufacturer.

D. Inspect each new instrument, control component, etc., before installation. Replace deficient items.

E. Touch-up and restore damaged surfaces to factory finish to match existing.

3.04 INSTALLATION REPORT

A. After installation, the manufacturer's representatives shall inspect the installation and prepare a report or reports to include the following:
   1. A list of all deficiencies found.
   2. Recommend corrective action for all deficiencies.
   3. Certification that the item or system is properly installed, except as noted.

3.05 FIELD CALIBRATION AND TESTING

A. Calibrate instruments and prepare calibration reports. All calibration shall be performed by factory-trained technical personnel. Calibration shall be witnessed by OWNER.

B. The complete system shall be tested by an experienced factory-trained technical person. All system tests shall be witnessed by OWNER.

C. Perform the following tests using simulated inputs:
   1. Check the overall system and each subsystem to see that they function as specified based on simulated inputs at each sensor and at each set of field

contacts monitored. This check shall include the testing of all automatic functions, sounding of alarms, shutdowns, etc.

2. Check the overall accuracy of each new and modified instrument loop to ensure that it is within acceptable tolerance.

D. If defects are found under simulated conditions, make corrections and retest.

E. After start-up, test the complete system under actual conditions to determine that all specified functions can be performed.

F. After completion of testing, submit a System Test Report. This report shall include:
   1. Certification that the system is operating correctly and within tolerances.
   2. Listing of calculated tolerances for each new and modified instrument loop.

3.06 OPERATION AND MAINTENANCE TRAINING

A. Start-up Training: Provide required instruction to the OWNER's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for a period of not less than two (2) working days for the purpose of instructing the OWNER’s personnel in the correct operating and maintenance procedures for all the instrument and hard-wired control system components and the entire Instrumentation and Control System, and Communications System including the various instrument and control system cabinets/panels installed in this project. This is in addition to the training requirements defined in other Sections of Division 17 of the Specifications. The date of this school shall be scheduled with the OWNER, but will be after the entire instrument and control systems is in operation. Also, refer to the additional training requirements defined in other Sections of Division 17 of the Specifications.

3.07 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 17302

FLOW MEASUREMENT: MAGNETIC FLOWMETERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Full-body magnetic flowmeters.

B. Provide all instruments identified in the Contract Drawings.

1.02 REFERENCES

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. International Organization for Standardization (ISO):
   1. 9000 - Quality management systems -- Fundamentals and vocabulary.
   2. 17025 - General requirements for the competence of testing and calibration laboratories.

C. National Institute of Standards and Technology (NIST).

D. NSF International (NSF).

1.03 DEFINITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01300 - Submittals and 17100 - Process Instrumentation and Control Systems (PICS).

B. Include sizing information from the manufacturer that includes:
   1. Chart of the measurement error from zero to maximum measured volumetric flow range indicated in data sheets.
   2. Indication of all input parameters and their values used in the calculations.

1.05 QUALITY ASSURANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

2. Physical conditions:
    a. Installation and mounting requirements.
    b. Location within the process.
    c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.08 WARRANTY

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.09 MAINTENANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or engineer approved equal:
    1. Emerson, Rosemount 8750W.
    2. Krohne, IFC.
    3. Siemens.

2.02 MANUFACTURED UNITS

A. Magnetic flowmeter:
    1. General:
        a. Magnetic flowmeters obtain the flow velocity by measuring the changes of induced voltage of the conductive fluid passing across a controlled magnetic field.
        b. Complete zero stability shall be an inherent characteristic of the flowmeter system.
        c. Include for each magnetic flow metering system:
            1) A metering tube with electrodes (sensor).
            2) Signal cable.
            3) Transmitters shall be remote-mounted.
            4) Flowmeter grounding rings.

2. Performance requirements:
    a. Accuracy:
        1) 0.25 percent of flow rate from 10 to 100 percent of full-scale for velocities ranging between 1.9 to 10 feet per second.
    b. Repeatability:
        1) 0.25 percent of rate.
3. Element:
    a. Metering tube:
        1) Constructed of carbon steel or Type 304 stainless steel (unless specifically noted otherwise in the instrument data sheets) with flanged connections to match with piping material.
        2) Liner material in conformance with:
            a) Manufacturer's recommendations for the intended service.
            b) NSF certified for all drinking water applications.
        3) Electrodes type and material in conformance with:
            a) Manufacturer's recommendations for the intended service.
            b) Utilize a minimum of 2**,** self-cleaning electrodes.
        4) Meter terminal housing NEMA Type 4X, unless installed in locations such as vaults that will experience submergence. In those applications NEMA 6P is required.
            a) Unless specifically noted otherwise in the instrument data sheets.
        5) Meter coating consisting of epoxy painted finish.
        6) Components:
            a) 2 grounding rings:
                (1) Which are in conformance with the manufacturer's bore and material recommendation for the meter's intended service.
4. Transmitter:
    a. Power supply:
        1) As indicated in the data sheets.
        2) Power consumption: 60 VA maximum.
    b. Outputs:
        1) As noted in the instrument data sheets.
        2) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
    c. Microprocessor-based signal converter/transmitter.
    d. Utilize DC pulse technique to drive flux-producing coils.
    e. Contain a 6-digit display for flow rate, percent of span, and totalizer.
    f. Operator keypad interface.
    g. Integral zero return to provide consistent zero output signals in response to an external dry contact closure.
    h. Integral low flow cut-off zero return.
    i. Programmable parameters including:
        1) Meter size.
        2) Full-scale flow rate.
        3) Magnetic field frequency.
        4) Time constant.
    j. Data retention for a minimum of 5 years without auxiliary main or battery power.
    k. Self-diagnostics and automatic data checking.
    l. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.

m. Ambient operating temperature limits of -5 to 140 degrees Fahrenheit (-20 to 60 degrees Celsius).
n. The transmitter should support commissioning options via a service interface or via an internal web server accessible through an RJ-45 Ethernet port.
o. The transmitter should retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure.
p. Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.

2.03 ACCESSORIES

A. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

B. Provide sunshades for all transmitters located outdoors.

C. Provide galvanic isolation gaskets, nylon/Teflon™ flange bolt insulation bushings and nylon washers on all meters installed on pipes with cathodic protection.

D. Furnish 1 spool piece for every size of magnetic flow tube being provided.

E. Electronic tester for calibration verification and diagnostics.
1. Transmitter shall have continuous internal meter verification method comparing current meter system values to base line value.
2. Should variance in readings be determined exceeding a preset limit the transmitter will provide an alarm condition via a configurable discrete output.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Factory calibrate each flow metering system at a facility that is traceable to the NIST. ISO-17025 accredited test facility with certified accuracy traceable to NIST.

C. Evidence of accreditation shall originate from a national verification agency such as A2LA.

D. A real-time computer generated printout of the actual calibration date indication actual velocities and as read values of the flow tube.
1. Flow calibration report of the manufacturers flow lab calibration procedure shall be shipped with the meter system.
2. Minimum calibration shall be a 3 point calibration including 1, 3, and 10 feet per second velocities for every meter and transmitter system.
3. Manufacturer shall archive all calibration reports for future reference.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

B. For instruments located outdoors or where instrument elements and transmitters are separated by conduit located outside the building envelope, provide surge protection devices at the transmitters.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide manufacturer's services to perform installation inspection.

3.05 ADJUSTING

A. Field Verification:
   1. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.
   2. The transmitter and sensor to include a method to verify flow meter performance to the original manufacturer specifications.
   3. Verification should be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
   4. The verification report should be compliant to common quality systems such as ISO 9000 to prove reliability of the meter specified accuracy.
   5. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

A. As specified in Section 01700 – Contract Closeout.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

B. Demonstrate performance of all instruments to the Engineer before commissioning.

3.08 PROTECTION

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

3.09 SCHEDULES

A. Instrument Data Sheets included in this Section.

B. The provided information does not necessarily include all required instruments.

C. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	Carollo Engineers, Inc.	MAGNETIC FLOWMETERS				INSTRUMENT DATA SHEETS	
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17302	
Project:	Wild Horse WWTP Expansion					Contract	Date
Customer:	City of Austin						
Plant:	Wild Horse WWTP					Req.	P.O.
Location:							
BOM No.:						By / Chk / App	
File:							

	1		Instrument Tag No.									
	2		Service									
	3		P&ID									
	4	C	Line Size / Schedule									
	5	O	Line Material									
	6	N	Connection Type/ Pressure Rating									
	7	N	Connection Materials									
	8		Tube Size									
E	9		Tube Material									
L	10		Liner Material									
E	11	M	Electrode Type	Mfg Standard								
M	12	E	Electrode Material									
E	13	T	Meter Casing									
N	14	E	Power Sply / Phase	120 VAC	1P							
T	15	R	Grounding Type & Matl.									
	16		Enclosure Class	NEMA 4X								
	17		Other									
	18		Fluid									
	19	F	Max Flow									
	20	L	Min Velocity									
	21	U	Min Flow / Norm Flow									
	22	I	Min Temp / Max Temp									
	23	D	Min Press / Max Press									
	24		Vacuum Possibility									
	25		Conductivity									
T	26		Function									
R	27		Mounting	Integral								
A	28		Enclosure Class	NEMA 4X								
N	29		Length Signal Cable									
S	30		Type Span Adjustment									
M	31		Power Supply									
I	32		Transmitter Output	4-20 mA HART								
			Relay Outputs	Form C								
T	33		Accuracy	0.25%								
T	34		Calibrated Range									
E	35		Empty Pipe Detection									
R	36		Bi-Directional Flow									
	37		Display Scale Size / Range									
	38		Alarm Contact No. / Form									
	39		Manufacturer									
	40		Element (Meter) Model No.									
	41		Transmitter (Inst.) Model No.									

Notes:

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SECTION 17305

FLOW MEASUREMENT: THERMAL MASS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Thermal mass flow measurement.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.03 DEFINITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Specific definitions:
   1. Surface mount technology: The practice and method of attaching leaded and non-leaded electrical components to the surface of a conductive pattern that does not utilize leads in feed-through holes. This technology reduces power requirements for the thermal flow instruments.
   2. Retract mechanism: A device that holds the sensor probe in place for the flow measurement. This device also includes a mechanism that enables the plant maintenance staff to remove the probe easily for cleaning and other maintenance needed. This device also enables the plant maintenance staff to re-insert the sensor probe back into its original position without leakage for measurement service again.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01300 - Submittals and 17100 - Process Instrumentation and Control Systems (PICS).

B. Design calculations:
   1. Flow modeling.

C. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17100 - Process Instrumentation and Control Systems (PICS).
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermal mass flowmeters:
   1. Dry gas measurement:
      a. Insertion mounting:
         1) One of the following or equal:
            a) Fluid Components International (FCI®), Model No. ST100.
            b) Kurz Instruments, Inc., Model No. 454FTB series.
            c) Sierra Instruments, Inc., Model No. 640S.

b. Inline mounting with integral flow conditioning:
1) One of the following or equal:
a) Kurz instrument, Inc., Model 534FTB
b) Fluid Components International (FCI®), Model ST100L.

2. Wet gas measurement (insertion mounting):
a. One of the following or equal:
1) Kurz Instruments, Inc.,
a) Single point: Model No. 454FTB-WGF series.
b) Multipoint: K-Bar 2000B series and Mass Flow Computer.
b. Fluid Components International LLC (FCI®), Model No. ST98 with thermal dispersion flow element, remote transmitter, and a balance retract mechanism for the probe sensor.

2.02 MANUFACTURED UNITS

A. Thermal mass flowmeter for wet gas measurement:
1. General:
a. Thermal mass flowmeters measure airflow, industrial, and process gas mass flows by detecting the heat transfer from a heated RTD sensor referenced to the temperature of the ambient gas stream sensor.
b. The electronic circuitry shall either maintain a constant differential temperature between the gas temperature and the heated element or a constant power.
c. The electronic circuitry shall deliver a linear signal proportional to the process fluid flow.
2. Performance requirements:
a. Accuracy:
1) 1.5 percent of full scale for velocities over 2 feet per second.
b. Repeatability:
1) 0.5 percent of full scale.
3. Element:
a. Sensor with terminal enclosure:
b. Utilize a sensor with 3/4-inch male NPT process connection.
c. No overheat at zero flow.
4. Transmitter:
a. Microprocessor-based.
b. Enclosure: NEMA Type 4X.
c. Power supply:
1) 120 VAC.
2) Power consumption: 50 VA maximum.
d. Outputs:
1) Isolated 4 to 20 mA DC with HART communication protocol.
e. Alphanumeric display for flow rate.
f. Ambient operating temperature limits: 0 to 150 degrees Fahrenheit.
5. Components:
a. Signal cable between insertion probe and transmitter:
1) Abrasive-resistant, polyurethane jacket.
2) Sensor cable permanently bonded to sensor.
3) Provide enough length of cable to allow removal and inspection of insertion element.

2.03 ACCESSORIES

A. Provide a balance retract geared mechanism for insertion and retraction of the probe sensor assembly.

B. Software (if available as either a standard or an option) for fully validation on instrument performances.

C. Provide sunshade for outdoor installations.

D. A hand held device (if available either in RS422/RS485-Modbus, Profibus-DP, DeviceNet or Ethernet) for communications on gas flow measurement.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

B. Install digester gas flowmeters 45 degrees below the horizontal to prevent condensation from building up on the tip.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide manufacturer's services to perform installation inspection services.

3.05 ADJUSTING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.06 CLEANING

A. As specified in Section 01700 – Contract Closeout.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.08 PROTECTION

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

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SECTION 17380

FIELD INSTRUMENTATION AND SENSING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. The work performed under this Section consists of furnishing, installing, calibrating and placing into satisfactory service the following field mounted devices/elements as shown on the PLANS:
   1. Intelligent Pressure Measuring Indicating Transmitters
   2. Pressure Switches
   3. Intelligent Temperature Measuring Indicating Transmitters
   4. Intelligent Temperature Measuring Transmitters
   5. Ultrasonic Level Element and Indicating Transmitters
   6. Ultrasonic Open Channel Level Controllers and Transducers
   7. Submersible Level Transducer and Transmitters
   8. Sludge Blanket Level Element and Indicating Transmitters
   9. Mechanical Liquid Level Switches
   10. Hydrogen Gas Analyzer and Indicating Transmitters
   11. Weight Measurement Electronic Load Cell and Indicating Transmitters
   12. Digital Loop Powered Indicators
   13. Tubing, Hand Valves and Fittings
   14. Wire Mesh Grips
   15. Cable Hangers
   16. Hoods (Sun-Shields)
   17. Stand-Pipes
   18. Supports Systems Constructed of Pipes and Pipe Fittings

B. Additionally, coordinate, install, assist in calibration, test, and place into satisfactory service the following field mounted devices furnished as described in Sections 17302, 17305, 17502, 17506, and 17522 of the following:
   1. Flow Measurement: Magnetic Flowmeters
   2. Flow Measurement: Thermal Mass
   3. Analyzers: ORP
   4. Analyzers: Dissolved Oxygen (DO)
   5. Analyzers: Total Suspended Solids (TSS)

C. Refer to the “Instrument List” on the PLANS.
   1. The minimum and maximum range in the Instrument List provides the required calibrated span of each instrument.
   2. Where the instrument functions as a switch, the minimum/maximum value indicates the low/high switch setting. Where the value is noted as “N/A”, the low or high setting is not applicable for the instrument.
   3. The Instrument List is not inclusive of all instruments required by this contract. Refer to Part 1 of this section for quantities of spare parts and instruments in addition to those listed in the Instrument List. Refer to the PLANS and other

specification sections for additional instruments required by these contract documents.

4. Where a PLAN sheet number is shown in the list, and a "/" is listed, the number shown prior the "/" refer to a specific detail number on that sheet.
5. The list includes PLAN drawing numbers applicable to the specific instrument installation and wiring. This list of drawing numbers is not complete. Refer to the PLANS for additional instances and requirements for these instruments.
6. Where items in the list are left blank and/or not entered, the CONTRACTOR shall note these items on the data submittals and request input from the Process Mechanical ENGINEER for clarification during submittal review.

D. Instrument Type Code:
   1. An Instrument Type Code identifies each instrument and consists of alphabetical character(s) followed by three numeral characters.
      a. Example Instrument Type Code: "A123".
   2. The Type Code listed in the Instrument List serves as a means to reference each instrument in the Instrument List to the specifications. Where the entry is noted as "N/A" in the Instrument List for a specific instrument, a Type Code is not required for the instrument.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

B. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

C. Related work as called for on the PLANS, as specified herein or in other Sections of the Specifications.

1.03 SUBMITTALS

A. Submit the following in accordance with the Section 01300 and 01730 of the Specifications and in accordance to Section 17100 of the Specifications:
   1. Shop Drawings and product data.
   2. Submit wiring schematics for all equipment.
   3. Submit listing of all field instrument nameplates and their inscriptions for review by OWNER prior to fabricating nameplates.
   4. Submit a physical mock-up of a product/item where a mock-up is noted/required for the product/item in this specification section.
   5. Submit certifications of training associated with the proper installation of fiberglass reinforced vinyl ester support channel systems.
   6. Test Reports: Completed and certified factory and field calibration data sheets for instruments and devices that require set-up and calibration.
      a. Include factory calibration for each instrument with stated accuracy.
   7. Operation and maintenance manuals.
      a. Include all completed and certified test reports in manuals.
         1) Refer to specifications herein for transmitter ambient and process fluid temperature ranges to be used for basis of accuracy analysis.

8. Submit detailed listing of training class curriculum including, as a minimum, the following at least four (4) months prior to class:
    a. Specific topics for each instrument, including but not limited to, general trouble-shooting, calibration, wiring, and general set-up/configuration.
    b. Anticipated duration of class for each instrument type.
    c. Names of instructor(s) for each specific instrument.
    d. Refer to instrument by Instrument Type Code as listed in this specification section where applicable.

1.04 QUALITY ASSURANCE

A. Standardization: All equipment of the same Instrument Type Code to be the product of a single manufacturer.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
    1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
    2. Physical conditions:
        a. Installation and mounting requirements.
        b. Location within the process.
        c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the ENGINEER if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Contractor shall be trained and certified by the Fiberglass reinforced vinyl ester support channel manufacturer in the proper installation of the fiberglass reinforced vinyl ester support channel system where such products are specified for this Work.

E. Material Compatibility:
    1. Material selections of instrument components noted in this section provide a basis for the minimum material compatibility requirements.
    2. Instrument component material selections shall be subject to additional restrictions and compliance with recommendations of instrument manufacturers for the intended service.
    3. Provide instrument component materials in compliance with specific process fluid temperature, pressure, chemical compatibility, and other process fluid parameters.

1.05 TOOLS AND SPARE PARTS

A. Furnish the following spare Field Instrumentation and Sensing Devices in conformance with the Specifications:
    1. One set of complete Type A105 Hydrogen Gas Analyzer and Indicating Transmitter, furnished complete with accessories specified.
    2. One set of complete Type I107 Digital Loop Powered Indicator, furnished complete with accessories specified.
    3. One set of complete Type L102 Ultrasonic Level Element and Indicating Transmitter, furnished complete with accessories specified.

4. One set of complete Type L209 Submersible Level Transducer and Transmitter, furnished complete with accessories specified.
5. One set of complete Type L205 Sludge Blanket Level Element and Indicating Transmitter, furnished complete with accessories specified.
6. One set of complete Type L223 Open Channel Ultrasonic Level Element and Indicating and Transmitter, furnished complete with accessories specified.
7. One set of complete Type L411 Mechanically Activated Level Switch, furnished complete with accessories specified.
8. One set of complete Type P104 Intelligent Pressure Measuring Indicator/Transmitter, furnished complete with accessories specified.
9. One set of complete Type P125 Intelligent Pressure Measuring Indicator/Transmitter, furnished complete with accessories specified.
10. One set of complete Type P403 Pressure Switch, furnished complete with accessories specified.
11. One set of complete Type T103 Intelligent Temperature Measuring Indicator/transmitter, furnished complete with accessories specified.
12. One set of complete Type T118 Intelligent Temperature Measuring Indicator/transmitter, furnished complete with accessories specified.
13. One set of complete Type T203 Intelligent Temperature Measuring Transmitter, furnished complete with accessories specified.
14. One set of complete Type W105 Weight Measurement Electronic Load Cell and Indicating Transmitter
15. Five sets of Instrument Tubing Hand Valves.
16. Five sets of Instrument Tubing Elbow Fittings and Tee Fittings.

B. Cable lengths and capillary lengths of spare instruments/equipment shall match that of installed respective type of instrument/equipment. Where lengths of same type of installed instruments are not the same, respective spare instrument shall be provided with cable length and/or capillary tubing length matching longest cable and/or capillary tubing length of respective set of instruments installed. Provide all accessories, kits and mounting hardware as specified for each spare instrument.

C. Spare instrument shall be configured to match one of the installed instruments.
   1. Where multiple instruments of the same type are installed:
      a. Configuration of spare instrument shall be as directed by Engineer during construction.
      b. Request input from Engineer during submittal process as to which configuration is desired for the spare instrument.

D. Furnish the following tools:
   1. Three (3) handheld HART communicator configurators, complete with 4GB RAM, 128 GB SSD, Camera, WLAN and WWAN LTE GPS for USA, English language operating system, Standard Charger and Power Cord USA, HART Commubox FXA195-S1 (CSA), and Microsoft adapter USB 3.0 to Ethernet as manufactured by Endress+Hauser Field Xpert Model SMT50-A11BL1BAAMC+MF with specified accessories, no equal.

1.06 MOCK-UPS

A. Where a mock-up is noted for a product/item specified in this section, provide each mock-up per the following requirements:

1. The Contractor shall construct/fabricate the mock-up and submit it for review only after shop drawings for the product/item associated with the mock-up have been developed and submitted by the Contractor for review and the review process of the shop drawings by the OWNER and ENGINEER is complete.
2. Hand the fabricated mock-up to the OWNER. Package the mock-in a cardboard box and/or otherwise protected from the elements during storage and handling.
3. Each mock-up shall be considered a sample with regard to the submittal procedures for this Work.
4. The mock-up protective packaging shall have a label that shall include, at a minimum, the following information typed on the label:
    a. Project title,
    b. Name of the submitting Contractor and Sub-Contractor, as applicable,
    c. Name of the intended recipient,
    d. Physical address of the intended recipient,
    e. Submittal number, and
    f. Submittal specification section.
5. Each mock-up shall be handed to the OWNER with a transfer of materials memorandum hard-copy document. The Contractor shall make a copy of the signed version of the transfer of materials memorandum and include it as part of the mock-up submittal documents. The transfer of materials memorandum shall include, at a minimum, the following information:
    a. Printed name and signature of the Contractor representative that handed the mock-up to the OWNER,
    b. Printed name and signature of the OWNER representative acknowledging recipient of the mock-up,
    c. A description of the mock-up submitted,
    d. The date and time of day the mock-up was handed to the OWNER, and
    e. The physical address of the location where the mock-up was handed to the OWNER.
6. For each physical mock-up submittal, provide mock-up submittal documents. The mock-up submittal documents shall include, at a minimum, the following:
    a. Standard submittal cover pages per the submittal procedures for this Work.
    b. A copy of the prior reviewed shop drawing of the mock-up.
    c. Pictures of the submitted physical mock-up.
        1) Six pictures, each enlarged on a letter sized page, one for each of the six (6) sides of the mock-up (top, bottom, right, left, back, and front sides).
        2) Additional pictures, with a measuring tape (units of inches showing) placed on the applicable features of the mock-up to illustrate the thickness/gauge and dimensions of materials used to fabricate the mock-up, where such material thicknesses and dimensions are specified for the product/item.
        3) Provide additional pictures as required to communicate details of the mock-up.
    d. A copy of the physical mock-up submittal transfer of materials memorandum.

7. All mock-ups required for this Work shall be in addition to the quantity of products/items to be installed as required per the specifications, the "Instrument List" and/or as shown on the DRAWINGS.
    a. All mock-ups shall be in addition to any spare parts noted in this section.
    b. All mock-ups shall remain the property of the OWNER and may not be used/installed by the Contractor as part of the final Work unless specifically authorized in writing by the OWNER or the ENGINEER.
8. For a product for which a mock-up is required, if there is more than one installation of the product/item, and the individual installations have different sizes and/or capacities, unless a specific size/capacity is noted to serve as the basis for the mock-up, the Contractor shall provide a mock-up of the installation having the largest size/capacity required for this Work.
    a. The Contractor shall note on the product shop drawings submitted for review prior to the mock-up submittal which size/capacity of the product shall serve as the basis for the mock-up.

1.07 ACCEPTABLE MANUFACTURERS

A. Each type of Instrument shall be manufactured by a single Instrument manufacturer and additional requirements as follows:
    1. All pressure indicating transmitters shall be manufactured by a single Instrument manufacturer.
    2. All temperature indicating transmitters shall be manufactured by a single Instrument manufacturer.
    3. All level indicating transmitters shall be manufactured by a single Instrument manufacturer.
    4. All tilting float and vertical lift rod float level switches shall be manufactured by a single manufacturer.
    5. All ultrasonic level indicating controllers/transmitters shall be manufactured by a single Instrument manufacturer.
    6. All hydrogen gas analyzer indicating controllers/transmitters shall be manufactured by a single Instrument manufacturer.
    7. All sludge blanket level indicating controllers/transmitters shall be manufactured by a single Instrument manufacturer.
    8. All submersible level transducer indicating controllers/transmitters shall be manufactured by a single Instrument manufacturer.

B. Refer to the individual instrument subsection in PART 2 - PRODUCTS, below.

PART 2 PRODUCTS

2.01 INTELLIGENT PRESSURE MEASURING INDICATING TRANSMITTERS

A. P100 Series General Requirements:
    1. The Pressure Indicator/Transmitter shall have the following features:
        a. Signal: Two-wire 4-20 mAdc (loop powered) and having an integral digital signal based on the HART communication protocol.
            1) Alarm: Configure the unit fault/alarm at 21.75 mAdc output signal.
        b. Accuracy: +/-0.025% of span; for spans less than 10:1, +/-[0.005 + 0.0035(URL / Span)]% of span; or greater accuracy.

1) The “URL” in the above accuracy statement is the Upper Range Limit of the instrument.

c. Measurement Stability Period: 15 years
d. Unit Warranty: 15 years
e. Ambient Temperature Range: –40 degrees Fahrenheit to +175 degrees Fahrenheit
f. DC Loop Supply Voltage Range: 12 to 42 VDC.
g. Signal Output Load Range: 200 to 1,450 ohms.
h. Measurement Range: Select the measurement range offered by the instrument manufacturer for the specified model series that offers the greatest available accuracy for the required span of measurement as listed in the “Instrument List”. Select gauge or absolute measurement as applicable.
i. Indicator Requirements:
    1) Type: Digital LCD integral to transmitter
    2) Calibration: Field configurable, as desired by the user
        a) Span: As listed in the “Instrument List”.
        b) Measurement Unit: As listed in the “Instrument List”.
j. Power: Loop powered (4-20mA at 24 VDC) with 1/2" NPT conduit connection.
k. Wetted Parts Material: Type 316L Stainless Steel.
l. Sensor traditional bottom works, process covers and process connectors: Type 316-Stainless Steel with supply vent screw in side of each process cover with traditional bottom works flange (not coplanar) configuration.
m. Sensor Fill Fluid: Silicone oil.
n. Process Connection: 1/2 inch NPT.
o. Transmitter Housing: Epoxy coated aluminum, explosion proof NEMA-4X.
p. Hardware and Bolting: Type 316 Stainless Steel.
q. Local Operation: The Indicator/Transmitter shall be equipped with operators on the face of the unit adjacent to the local indicator for configuration and calibration functions. The face of the unit is the side of the unit that includes the local indicator.

2. Process Pipe Pressure Tap Valves: Refer to PLANS for valving on process piping pressure tap, in addition to any instrument valves specified in this section.
3. Mounting: Manufacturer’s Type 316 Stainless Steel mounting bracket suitable for mounting transmitter assembly on 2-inch pipe stand, support channel, wall/panel or other surface as shown on PLANS. Provide stainless steel flange to mount vertical pipe stand to floor. Refer to the PLANS for additional requirements.
4. Instrument Tubing: Provide instrument tubing to process line connections at valve block process ports. Refer to tubing and fittings requirements in this Specification Section. Refer to PLANS for additional requirements.
5. Vent Screen Fittings: Provide a vent screen fitting for each instrument and/or valve manifold process connection port that is not directly connected to instrument tubing. Each vent screen fitting shall have Type 316 Stainless Steel trim and body construction and shall be of the same size as the instrument or valve manifold port to which the vent screen fitting is connected.
6. Bluetooth Wireless Configuration Capability: The Indicator/Transmitter shall be equipped with integral Bluetooth capability to communicate wirelessly with a remote communicator/configurator, Smartphone/Tablet App and PC via

Bluetooth via encrypted single point-to-point data transmission and password protected communication for up to 82 feet wireless range.

7. The Intelligent Pressure Measuring Indicators/Transmitters shall be as manufactured by Endress+Hauser Series Cerabar PMP71B or greater accuracy (Intelligent Transmitters) with specified accessories, or Engineer approved equal.

B. P104: Intelligent Pressure Measuring Indicating Transmitter with Block Valve and Tubing
   1. General Requirements for P100 Series Intelligent Pressure Measuring Indicating Transmitters apply to this type of instrument.
   2. Instrument Valves: Provide factory furnished, 2-way Valve Block Manifold; constructed of 316 Stainless Steel wetted and non-wetted parts, to accept 1/2 inch NPT; with gaskets, PTFE packing, and 316 Stainless Steel bolts; Anderson Greenwood Model M4TP-VIS4 with Model AMS Type 316 Stainless Steel mounting bracket or Engineer approved equal. Refer to PLANS for additional valving on process piping pressure tap.
   3. Mounting of Manifold and Transmitter: Mount manifold directly with specified manifold mounting bracket. Manifold shall be installed between Transmitter bottom works and bracket. Transmitter shall be supported by manifold.
   4. Instrument Tubing: Provide instrument tubing to process line connections at valve block process port. Refer to tubing and fittings requirements in this Specification Section. Refer to PLANS for additional requirements.

C. P125: Intelligent Pressure Measuring Indicating Transmitter with Integral Threaded Diaphragm Seal
   1. General Requirements for P100 Series Intelligent Pressure Measuring Indicating Transmitters apply to this type of instrument.
      a. Exception: The Type P125 Intelligent Pressure Measuring Indicator/Transmitter shall not have a bottom works (traditional or coplanar). Each Type P125 Intelligent Pressure Measuring Indicator/Transmitter shall be an In-line Pressure Transmitter configuration and specified accessories, or Engineer approved equal.
   2. Pressure Seal Requirements:
      a. Temperature Error: Less than 0.1% instrument error based on the listed pressure span when the volume of fill fluid is subject to a 30 degree Fahrenheit change in temperature.
      b. Pressure Ratings: Rated for same pressure as the process piping system that it serves and shall be continuous-duty design rated to prevent loss of process fluid if pressure instrument is removed or fails.
      c. Fill Fluid: Inert fill fluid shall be used where the process fluid is a strong oxidizing agent, including but not limited to, oxygen, chlorine, fluorine, nitric acid, and hydrogen peroxide.
      d. Material Compatibility: For process fluids not noted in this Specification Section, coordinate with the Diaphragm Seal Factory for recommended material compatibility and submit to ENGINEER for review.
   3. Diaphragm Pressure Seal: Provide factory furnished, factory assembled pressure transmitter assembly including diaphragm seal with fill fluid factory filled and sealed, PIC Technologies Emerson Automation Solutions T4 Series, or Engineer approved equal. Provide seal system to comply with the following requirements:

a. Type: Integral mount, One Seal System
b. Size: 4 inch diameter diaphragm
c. Process Connector: 1” threaded NPT, internal threads located at bottom center of lower housing
d. Pressure Rating: Housing, diaphragm and bolt system rated for 750 psig minimum process fluid pressure
e. Lower Housing Material (Process Wetted): 316 Stainless Steel
f. Diaphragm Material: 316L Stainless Steel
g. Upper Housing Material: 316L Stainless Steel
h. Gasket: Teflon (PTFE)
i. Instrument Connection: Factory installed diaphragm seal onto the transmitter. Orient and position the diaphragm seal relative to the required side of the transmitter bottom works to allow the installation of the transmitter and to provide a fully accessible and functional system. Refer to PLANS for additional requirements.
j. Flushing Connector: Two (2) 1/2" NPT on each side of lower housing, with plug having same material as lower housing.
k. Bolting: Type 316 Stainless Steel
l. Fill Fluid: DC200, 10 cSt Silicone

D. P131: Intelligent Pressure Measuring Indicating Transmitter with Remote Threaded Diaphragm Seal
1. General Requirements for P100 Series Intelligent Pressure Measuring Indicating Transmitters apply to this type of instrument.
2. Pressure Seal Requirements:
a. Temperature Error: Less than 0.1% instrument error based on the listed pressure span when the volume of fill fluid is subject to a 30 degree Fahrenheit change in temperature.
b. Pressure Ratings: Rated for same pressure as the process piping system that it serves and shall be continuous-duty design rated to prevent loss of process fluid if pressure instrument is removed or fails.
c. Fill Fluid: Inert fill fluid shall be used where the process fluid is a strong oxidizing agent, including but not limited to, oxygen, chlorine, fluorine, nitric acid, and hydrogen peroxide.
d. Material Compatibility: For process fluids not noted in this Specification Section, coordinate with the Diaphragm Seal Factory for recommended material compatibility and submit to ENGINEER for review.
3. Diaphragm Pressure Seal and Capillary Tubing: Provide factory furnished, factory assembled pressure transmitter assembly including capillary tubing and diaphragm seal, with fill fluid factory filled and sealed, PIC Technologies Emerson Automation Solutions T4 Series, or Engineer approved equal. Provide seal system to comply with the following requirements:
a. Type: Remote mount, One Seal System
b. Size: 4 inch diameter diaphragm
c. Process Connector: 1” threaded NPT, internal threads
d. Pressure Rating: Housing, diaphragm and bolt system rated for 750 psig minimum process fluid pressure
e. Lower Housing Material (Process Wetted): 316 Stainless Steel
f. Diaphragm Material: 316L Stainless Steel
g. Upper Housing Material: 316L Stainless Steel
h. Gasket: Teflon (PTFE)

i. Instrument Connection: 1/4" NPT Capillary welded to transmitter.
j. Flushing Connector: Two (2) 1/2" NPT on each side of lower housing, with plug having same material as lower housing.
k. Bolting: Type 316 Stainless Steel
l. Fill Fluid: DC200, 10 cSt Silicone
m. Capillary Internal Diameter: 0.040 inches
n. Capillary Type: Type 316L Stainless Steel Flexible Armor with Protective Coat
o. Capillary Outer Diameter: 0.294 inches, including flexible armor and protective coat.
p. Capillary Length: Size length of tubing to suit installed conditions and to allow a minimum of 3 feet and a maximum of 8 feet of slack.

2.02 PRESSURE SWITCHES

A. P403: Pressure Switch, Epoxy Coated Aluminum Enclosure
1. General Requirements:
a. Setpoint: Field adjustable.
b. Setpoint Repeatability: +/- 1% of full range plus a maximum additional allowable setpoint shift of +/- 1% of range per 50-degree Fahrenheit from initial setpoint set at 70-degrees Fahrenheit.
c. Enclosure Rating: NEMA 4X.
d. Enclosure Material: Epoxy coated aluminum.
e. Diaphragm Seal Material: Teflon.
f. Pressure Connection: 1/2 NPT Male.
g. Electrical Output: Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switch is shown on the PLANS. Switch rating shall be for narrow deadband and rated at 5 A at 125/250 VAC.
h. Electrical Termination: 3/4 NPT Female.
i. Ambient Temperature Range: -20 to 150-degrees Fahrenheit.
j. Process Temperature Range: 0 to 150-degrees Fahrenheit
k. Temperature at Factory Calibration: 70-degrees Fahrenheit
l. Pressure Range: Refer to Instrument List for the required pressure setpoint/range requirement. Select a unit pressure range that is at least 1.5 times or greater the pressure shown in the “Instrument List”.
1) Where manufacturer offers multiple pressure ranges, select the lowest available pressure range that complies with the above noted pressure range requirement and yields the greatest measurement accuracy of the manufacturer offered pressure ranges.
2) Provide vacuum, compound or positive pressure type pressure switch as required to comply with the pressure range noted in the “Instrument List”.
m. Reset: Automatic unless noted otherwise on the PLANS or the “Instrument List”.
n. Switch Assemblies: Hermetically sealed switches suited for narrow deadband.
o. Approvals: UL E34743.
p. Snubber Accessory:
1) Pressure Connection: 1/2 NPT.
2) Materials:
a) Housing: R Monel.

b) Filter Disc: Monel.
3) Pressure Rating: 15,000 PSI.
4) Porosity: Select porosity suitable for process fluid as recommended by manufacturer.

q. Isolation/Block and Bleed Valve:
1) Pressure Connections:
a) Inlet: 1/2 Female NPT
b) Outlet: 1/2 Female NPT
c) Vent: 1/4-inch
2) Materials:
a) Body, Bonnet, Stem and Ball: Type 316 Stainless Steel.
b) Packing: PTFE
3) Pressure Rating: 6,000 PSI.

2. Each Pressure Switch shall be as manufactured by Ashcroft Series B4 with the specified accessories, Ashcroft Model 50-1112M pressure snubber, and Anderson Greenwood Model M25-VIS4 block and bleed valve, or Engineer approved equal.

2.03 INTELLIGENT TEMPERATURE MEASURING INDICATORS/TRANSMITTERS

A. T100 Series General Requirements:
1. The Temperature Indicators/Transmitters shall be of the intelligent type and shall measure and convert the temperature from a temperature sensor element to a 4-20 mAdc electrical and digital output that is Linear with the actual temperature of fluid being measured.
2. The Temperature Indicator/Transmitters shall have the following features:
a. Communication Signal: Two-wire 4-20 mAdc (loop powered) and HART digital output (software selectable) proportional and Linear with the actual measured temperature of the process variable.
b. Temperature Span: 140 degrees F to 1200 degrees F.
c. Accuracy: 0.02 percent of calibrated span of the 4-20mA analog output
d. Stability: 0.25 percent of calibrated span or 0.5 degrees Fahrenheit, whichever is greater, for five years.
e. Operating Temperature: –40 degrees Fahrenheit to +185 degrees Fahrenheit.
f. Unit Warranty: 5 years
g. DC Loop Supply Voltage: 12 to 42 VDC.
h. Output Load: 0 to 1,250 ς (Ohms).
i. Conduit Connection: 1/2 inch NPT.
j. Digital Accuracy: +/- 0.18 degrees Fahrenheit.
k. Hardware: All bolts, process connections, and hardware shall be Type 316 Stainless Steel.
l. Housing:
1) Enclosure of the Indicator/Transmitter shall be Low-copper aluminum.
2) Rated for use in Class-I, Division 1, Groups C and D hazardous areas (as classified by NFPA 70 National Electrical Code).
m. Local Indication:
1) Local indicator (integral to Indicators/Transmitters) which is calibrated in “degrees F” and to the range of the transmitter (or to the range of the process variable range selected by the Owner).

2) The indicator shall be of the digital type with liquid crystal display (LCD), driven by the loop power (4-20mA at 24 VDC), and have an accuracy within 0.075 percent full scale.

n. Local Operators:
1) The Indicators/Transmitters shall be equipped with operators on the face of the unit for configuration and calibration functions.
2) External and/or internal source/devices (such as handled programmer and/or Portable Computer) shall not be required in order to configure, program, and calibrate the Indicators/Transmitters.

o. Mounting Hardware: Manufacturer's Type 316 Stainless Steel mounting bracket suitable for mounting transmitter on 2-inch pipe stand, support channel, wall/panel or other surface as shown on PLANS. Refer to the PLANS for additional requirements.

3. The Temperature Sensor Element for each Indicator/Transmitter shall have the following features:
a. General: 4-wire, single element, 100ς (Ohms) Resistance Thermometer Detector (RTD), Platinum, in accordance with IEC 751/60751 Class A (Tolerance Class W 0.15 or F 0.15).
b. Enclosure: Enclosed in a Type 321 Stainless Steel or approved sheath rated for up to 1,500 degrees Fahrenheit.
c. Sensor Assembly: Type 316 Stainless Steel spring-loaded style sensor assembly having 1/2 inch NPT.
d. Temperature Range: -58 to +572 degrees Fahrenheit.
e. Length: Provide length of element required to span entire length of thermowell and required sensor connections.

4. The Sensor Element Thermowell shall have the following features:
a. General: Each Sensor Element shall be provided with a Type 316 Stainless Steel Full Length thermowell (protecting tube).
b. Shank Style: Tapered shank geometry, with smaller diameter at terminal tip of thermowell.
c. Hardware: The thermal well assembly shall be furnished complete with external threads, explosion proof union, and required accessories/hardware for installation onto process mechanical piping, duct/chamber and/or raceways shown on PLANS. All mounting accessories/hardware shall be constructed of Type 316 Stainless Steel.
1) Exception: Union is not required when thermowell is mounted only to transmitter and not mounted to process mechanical piping, duct/chamber, raceways or other fixed element.

5. Each Intelligent Temperature Measuring Indicator/Transmitter along with the associated Temperature Sensing Element and System shall be as manufactured by Rosemount Series 644 Intelligent Temperature Transmitters with Series 214C Sensor Element, Series 114C Thermowell and specified manufacturer furnished accessories, or Engineer approved equal.

B. T103: Intelligent Temperature Measuring Indicators/Transmitters with Integral Temperature Element for Ambient Temperature Measurement
1. General Requirements for T100 Series Intelligent Temperature Measuring Indicators/Transmitters apply to this type of instrument.
2. The Temperature Indicator/Transmitters shall have the following features:
a. Mounting: Integral to sensor.
3. The Sensor Element Thermowell shall have the following features:

a. Length: 6 inches.
b. Sensor Assembly Connection: Mounted directly to Indicating Transmitter with required 316 Stainless Steel connector fittings.
1) Sensor element shall be factory assembled and threaded into thermowell and torqued for process-ready installation.
2) Sensor element shall be factory threaded into connection head with transmitter and torqued for process-ready installation; sensor shall be factory wired to the transmitter.

C. T118: Intelligent Temperature Measuring Indicators/Transmitters with Remote Mounted Temperature Element for Process Measurement
1. General Requirements for T100 Series Intelligent Temperature Measuring Indicators/Transmitters apply to this type of instrument.
2. The Temperature Indicator/Transmitters shall have the following features:
a. Mounting: Remote from sensor.
3. The Sensor Element Thermowell shall have the following features:
a. Thermowell Insertion Length:
1) Pipe Installation: Equal to the radius (based on nominal diameter) of the process pipe in which thermowell is inserted. Maximum length of 36 inches.
a) Note: For pipe diameter equal to 3-inches or less, provide custom fabricated thermowell as required to comply with above requirement.
2) Duct Installation: Equal to one-half the depth of the duct (the depth of duct parallel to the direction of insertion of the thermowell) of the process duct in which thermowell is inserted. Maximum length of 36 inches.
b. Sensor Assembly Connection: 1/2 inch NPT threaded to sensor.
1) Sensor element shall be factory assembled and threaded into thermowell and torqued for process-ready installation.
c. Process Connection:
1) Thermowell Length 12 Inches or Less: 3/4 inch NPT threaded to process pipe.
2) Thermowell Greater Than 12 Inches: 1-1/4 inch NPT threaded to process pipe.
d. Terminal Enclosure Connection Head:
1) NEMA-4X, polyurethane coated, die-cast aluminum, explosion proof rated and certified enclosure.
2) Extended height enclosure connection head with field removable and gasketed cover.
3) Terminal blocks for termination of sensor and field wiring inside terminal enclosure connection head.
4) Stainless steel cover chain to keep the field removable cover connected to the terminal enclosure body when the cover is temporarily removed.
5) Electrical Connection: 3/4 inch NPT threaded.

2.04 INTELLIGENT TEMPERATURE MEASURING TRANSMITTERS

A. T203: Intelligent Temperature Measuring Transmitters with Integral Temperature Element for Ambient Temperature Measurement

1. The Temperature Transmitters shall measure and convert the temperature from a temperature sensor element to a 4-20 mAdc electrical and digital output that is Linear with the actual temperature of fluid being measured.
2. The Temperature Transmitters shall have the following features:
    a. Communication Signal: Two-wire 4-20 mAdc (loop powered) proportional and Linear with the actual measured temperature of the process variable.
    b. Factory Pre-calibrated Temperature Span: As listed in the “Instrument List”.
        1) Note: Where span is not listed in the “Instrument List”, default span shall be 0 to +200 degrees Fahrenheit.
    c. Accuracy: 0.1 percent of calibrated span of the 4-20 mA analog output, includes effects of linearity, hysteresis, and repeatability referred to temperature input.
    d. Nonlinearity: 0.1 percent of calibrated span of the 4-20 mA analog output relative to a 100 ohm platinum RTD. Alpha shall equal 0.00385 standard curve for nominal range. Based on 4:1 minimum improvement on nonlinearity otherwise.
    e. Thermal Effect:
        1) Zero Shift: 0.02 percent of calibrated span of the 4-20 mA analog.
        2) Span Shift: 0.02 percent of calibrated span of the 4-20 mA analog.
    f. Circuitry: Epoxy Encapsulated. Analog Circuitry with sealed potentiometers.
    g. Power Supply:
        1) Working Voltage: 8.5 to 35 VDC.
        2) Supply Voltage Effect: Less than 0.001 percent of calibrated span of the 4-20 mA analog output per Volt.
    h. Loop Considerations:
        1) Loop Resistance Load Effect: Less than 0.002 percent of calibrated span of the 4-20 mA analog output per 300 Ohms.
        2) Maximum Loop resistance: (Voltage supply -8.5 Voltage) / 20 mA.
    i. RFI Immunity:
        1) Rated Class 3-C: 0.25 percent of calibrated span of the 4-20 mA analog output per SAMA PMC 33.1-1987-2abc.
    j. Frequency Response: Output -3dB at 3 Hertz Input.
    k. Temperature range:
        1) Ambient: -13 to +185 degrees Fahrenheit.
        2) Storage: -85 to +257 degrees Fahrenheit.
    l. Humidity:
        1) 0 to 95 percent noncondensing.
    m. Input: 100 ohm platinum RTD, Alpha equals 0.00385.
    n. Output:
        1) Signal Range: 4 to 20 mA DC.
        2) Absolute Limit: 2 to 29 mA.
        3) Open RTD Indication: Output greater than 22 mA.
    o. Calibration Range Adjustability:
        1) Zero: 25 percent of normal span.
        2) Span: 25 percent of normal span.
3. Factory Furnished Accessories:
    a. Connection Head: Screw top.
    b. Sensor:
        1) Type: RTD spring loaded fitting with 4-inch sheath.

2) Sensor Assembly Connection: Mounted directly to Transmitter.
c. Thermowell:
1) Mounting: Integral to sensor.
2) Length: 4 inches.
3) Thermowell Assembly Connection: Mounted directly to Transmitter.
4. Mounting Hardware: Manufacturer's Type 316 Stainless Steel mounting bracket suitable for mounting transmitter on 2-inch pipe stand, support channel, wall/panel or other surface as shown on PLANS. Refer to the PLANS for additional requirements.
5. Each Intelligent Temperature Measuring Transmitter along with the associated Temperature Sensing Element and System shall be as manufactured by DEVAR, Inc., Series SM812-EC Temperature Transmitters with Type CHA Connection Head, Type RTDSF-4 Series Sensor Element per Factory Drawing 515315-0003, Type W4 Thermowell and specified manufacturer furnished accessories, or Engineer approved equal.

2.05 ULTRASONIC LEVEL ELEMENT AND INDICATING TRANSMITTERS

A. L100 Series General Requirements:
1. The Transmitter/Controller shall have the following features:
a. Operation and Performance:
1) Solid-state microprocessor controlled digital circuitry.
2) Operating Temperature: -4 to +122 degrees Fahrenheit.
3) Temperature Compensation: Equipped with air temperature compensation corrosion resistant probe. The temperature probe shall be a separate device from the ultrasonic transducer.
4) Range/Span Adjustment Resolution: 0.012 inches for operating span of 1 to 50 feet and direct reading zero adjustments.
5) Minimum Span: 0 to 4 inches.
6) Maximum Span: 0 to 50 feet.
7) Accuracy: +/- 0.25 percent of span.
8) Blanking: adjustable distance from 16-inches to maximum span limits.
b. Enclosure: NEMA-4X, wall mount, corrosion resistant, watertight, and rated/suitable for use in NEC Class-1 Division-2 area installation.
c. Interface and Display:
1) LCD indicator reading; level in engineering units.
2) Keypad for programming the system and accessing diagnostics.
a) Note: The unit shall have a minimum of four (4) buttons and additional as needed on the unit integral keypad and a menu system to allow for the required programming and configuration without the need of a hand-held programmer.
d. Signals: 4-20mA DC output proportional to level measurement and all of the full-scale volume or head range.
e. Auxiliary Relays:
1) Furnished with six (6) auxiliary relays for remote alarm/process equipment control.
a) Four relays shall each have a Form A normally open dry contact, rated 5 amps at 120VAC.
b) Two relays shall have single-pole-double-throw (SPDT) dry contacts, rated 5 amps at 120VAC.

2) In the case of momentary signal loss, relays shall maintain their last state.

f. Power:

1) Main Supply: 120VAC, 60Hz power source.

2) Program Memory: Non-volatile for a period of six (6) months via a Ni-Cad battery pack (furnished with the system); charged continuously.

2. Temperature Transducer and Signal Cable shall have the following features:

a. Enclosure: Totally encapsulated corrosion resistant ETFE.

b. Mounting: Refer to the PLANS for mounting requirements of the temperature transducer.

c. Connections: 3/4-inch conduit hub for conduit/wire termination.

d. Cable: Length: As required per PLANS for connection to the transmitter/controller without any cable splices. Transmitter may be located up to 1,000 feet from the transducer.

3. Each Ultrasonic Level Indicator/Transmitter and Transducer assembly shall be as manufactured by Siemens Milltronics HydroRanger 200 HMI with Siemens Milltronics TS-3 remote mounted Transducer/Temperature Sensor (compensator), or Engineer approved equal.

B. L102: General Purpose Ultrasonic Level Transducer Requirements

1. General Requirements for L100 Series Ultrasonic Level Element and Indicating Transmitter apply to this type of instrument.

2. Transducer and Signal Cable shall have the following features:

a. Operation:

1) Beam Angle: 3.0 degrees maximum from centerline.

2) Operating Temperature: -40 to +203 degrees Fahrenheit.

3) Span: Refer to the “Instrument List”. Provide transducer from approved series to provide greatest precision within span.

b. Enclosure: PVDF, watertight, corrosion resistant, hermetically sealed NEC Class-1 Division-1 rated and submersible.

c. Submergence: Skirt/coupling for submergence detection.

d. Signal to Transmitter/Controller: 24 volts.

e. Cable:

1) Type: RG-62U Coaxial type instrumentation cable, plenum rated as manufactured by Belden, or Engineer approved equal.

2) Length: As required per PLANS for connection to the transmitter/controller without any cable splices. Transmitter may be located up to 1,000 feet from the transducer.

f. Mounting: Flange, suspended, or conduit mounting as specifically shown on the PLANS. Provide factory flange adaptor for required installation.

g. Connections: 1-inch conduit hub for conduit/wire termination. The use of plastic fasteners or special gaskets to prevent ringing is unacceptable.

3. Each Ultrasonic Transducer shall be as manufactured by Siemens Milltronics Echomax XPS Series Transducer or Engineer approved equal.

2.06 ULTRASONIC OPEN CHANNEL LEVEL CONTROLLERS AND TRANSDUCERS

A. L223: Requirements:

1. The Transmitter/Controller shall have the following features:

a. Operation and Performance:

1) Solid-state microprocessor controlled digital circuitry.

2) Operating Temperature: -4 to +122 degrees Fahrenheit.
3) Temperature Compensation: Equipped with air temperature compensation corrosion resistant probe. The temperature probe shall be a separate device from the ultrasonic transducer.
4) Range/Span Adjustment Resolution: 0.012 inches for operating span of 1 to 196 feet and direct reading zero adjustments.
5) Accuracy:
a) Within 9.84 feet range: +/- 0.04 inch.
b) Greater than 9.84 feet range: +/- 0.04 inch plus 0.17 % of measured distance.
6) Resolution:
a) Within 9.84 feet range: +/- 0.02 inch.
b) Greater than 9.84 feet range: 0.1% of range or 0.08 inch, whichever is greater.

b. Enclosure: NEMA-4X, wall mount, corrosion resistant, polycarbonate, watertight, and rated/suitable for use in NEC Class-1 Division-2 area installation.
c. Interface and Display:
1) LCD indicator reading; level in engineering units.
2) Keypad for programming the system and accessing diagnostics.
d. Signals: 4-20mADC isolated output proportional to level or flow measurement.
1) Refer to the “Instrument List” for the required unit of measure and configure the instrument accordingly.
e. Auxiliary Relays:
1) Furnished with three (3) auxiliary relays for remote alarm/process equipment control.
a) One (1) single-pole-double-throw (SPDT) Form C, normally-open or normally-closed relay, rated 1A at 250 V AC, non-inductive and 3A at 30 V DC.
b) Two (2) single-pole-single-throw (SPST) Form A, normally-open relays, rated 5A at 250 V AC, non-inductive and 3 A at 30 V DC.
2) In the case of momentary signal loss, relays shall maintain their last state.
f. Power: Main Supply: 120VAC, 60Hz, 36VA power source.
g. Program Memory:
1) 512 kB flash EPROM.
2) 1.5 MB flash for data logging.

2. Temperature Transducer and Signal Cable shall have the following features:
a. Enclosure: Totally encapsulated corrosion resistant ETFE.
b. Mounting: Refer to the PLANS for mounting requirements of the temperature transducer.
c. Connections: 3/4-inch conduit hub for conduit/wire termination.
d. Cable: Length: As required per PLANS for connection to the transmitter/controller without any cable splices. Transmitter may be located up to 1,000 feet from the transducer.
3. Transducer and Signal Cable shall have the following features:
a. Operation:
1) Beam Angle: 5.0 degrees maximum from centerline.
2) Operating Temperature: -4 to +149 degrees Fahrenheit.

3) Span: Refer to the “Instrument List”. Provide transducer from approved series to provide greatest precision within span.
b. Enclosure: PVDF, watertight, corrosion resistant, hermetically sealed NEC Class-1 Division-1 rated and submersible.
c. Submergence: Skirt/coupling for submergence detection.
d. Signal to Transmitter/Controller: 24 volts.
e. Cable:
1) Type: RG-62A/U Coaxial type instrumentation cable, plenum rated as manufactured by Belden, or Engineer approved equal.
2) Length: As required per PLANS for connection to the transmitter/controller without any cable splices. Transmitter may be located up to 600 feet from the transducer.
f. Mounting: Flange, suspended, or conduit mounting as specifically shown on the PLANS. Provide factory flange adaptor for required installation.
g. Connections: 1-1/2 inch conduit hub for conduit/wire termination.
4. Each Ultrasonic Level Indicator/Transmitter and Transducer assembly shall be as manufactured by Siemens SITRANS LUT440 High Accuracy OCM with a Siemens TS-3 remote mounted Transducer/Temperature Sensor (compensator), and Siemens Milltronics Echomax XRS-5 Ultrasonic Transducer with specified options and accessories, or Engineer approved equal.

2.07 SUBMERSIBLE LEVEL TRANSDUCER AND TRANSMITTERS

A. L209: Requirements:
1. General:
a. The Submersible Level Transducer/Transmitter shall convert the pressure applied to one diaphragm, with the low side open to atmosphere, to a 4 to 20mAdc output signal that is proportional to pressure.
2. The Submersible Level Transducer/Transmitter shall have the following features:
a. Two-wire 4-20mAdc (loop powered) proportional to head Pressure, 13 to 30 VDC power.
b. Range as shown in the “Instrument List”.
c. Transducer shall be suitable for continuous submergence.
d. Transducer shall be suitable for submergence in sludge fluid applications.
e. Temperature Range:
1) Sensor Limit: 0 degrees Fahrenheit to + 200 degrees Fahrenheit.
2) Compensated Temperature Range: 0 degrees Fahrenheit to + 180 degrees Fahrenheit.
f. Pressure Limit: 2 times full scale of measurement, minimum.
g. Sensor Full Scale Accuracy: Plus or minus 0.25 percent of full span
h. Thermal Error: Plus or minus 0.02 percent of full span per degree Fahrenheit maximum.
i. Barometric Effect: None.
j. Transducer Internal Pressure Relief Means:
1) Dedicated breather tube integral with jacketed hose/cable assembly that terminates at a maintenance free desiccant filter.
2) Pressure relief filter/means shall require no refilling or maintenance.
k. Pressure Transducer:

1) Body Housing Wetted Materials: Type 316-Stainless Steel, Type 316L-Stainless Steel, and Epoxy.
2) Cable Jacketing Material: ETFE.
3) Face Type: Diaphragm face.
4) Diameter of Transducer Body: 3-7/16-inch maximum at face of diaphragm section.
5) Support: Factory furnished hanger for cable support. Provide complete support system assembly, including hanger and clamps for a complete installation. All support components, including but not limited to the hanger and clamps shall be Type 316 Stainless Steel. Refer to the PLANS for additional requirements.

l. Transducer Features:
1) Units of Measurement: Calibrated in “feet and tenths of a foot”, and to the range of the transmitter.
2) Response Time: 50 milliseconds.
3) Loop Resistance: 900 Ohms.
4) Electrical Protection: Factory furnished and installed lighting and surge protection.
5) Weight: 4.3 pounds.
6) Agency Approvals: CE.

m. Submersible Level Transducer/Transmitter interconnect jacketed hose/cable assembly shall have the following features:
1) ETFE jacket.
2) Contains signal cable and flexible breather tube.
3) Water-resistant.
4) Minimum cable length: Coordinate cable length with the PLANS and provide the length necessary for the application, inclusive of the additional cable that is to be coiled adjacent to the transmitter as shown on the PLANS.

3. Mounting:
a. Provide all necessary Type 316 Stainless Steel hardware to interconnect all components.
b. Provide cable suspension type mounting with the following features:
1) Provide 1/8-inch diameter Type 316 Stainless Steel transducer suspension cable for suspension of transducer and associated Type 316 Stainless Steel cable hook and Type 316 Stainless Steel clamp. Coordinate cable length with the PLANS and provide the length necessary for the application.
a) Provide Type 316 Stainless Steel cable hook accessory threaded onto transducer and required mounting mechanisms for a complete and functional installation. Refer to the PLANS.
2) One (1) mounting Type 316 Stainless Steel ASTM A 312 Schedule 80 pipe having a length of two (2) feet minimum, a 1-inch minimum nominal pipe diameter, and the following additional features/accessories.
a) Provide a Type 316 Stainless Steel threaded reducer fitting/coupling as required on each of the two (2) ends of the mounting pipe to connect one end of the pipe to the transducer housing and the other end to the cable hook. The hook shall be constructed and attached to the pipe such that the adjoining fluid

fills the interior of the mounting pipe and there is no air trapped inside the pipe.

b) Increase the length of the mounting pipe beyond the minimum length specified as required to counteract the buoyancy effect for the fluid in which the transducer is submerged. The transducer and pipe weight assembly specific gravity shall be at least two (2) times the specific gravity of the fluid in which the transducer is submerged. Coordinate the specific gravity of the fluid in which the transducer is submerged with the Process Engineer prior to the submittal of the instrument equipment data and show/confirm on the submittal data sheets the fluid specific gravity and the furnished instrument assembly specific gravity.

c. Comply with the requirements of the PLANS.

d. Install in accordance to Manufacturer's recommendations and coordinate final setpoint with the Owner.

4. Each Submersible Pressure Transducer/Transmitter, and all other accessories specified shall be furnished by the same manufacturer. Submersible Pressure Transducer/Transmitters shall be as manufactured by Dwyer Instruments Inc., Series PBLT2 MERCOID, complete with cable, filter, hook and the additional specified accessories, or Engineer approved equal.

2.08 SLUDGE BLANKET LEVEL ELEMENT AND INDICATING TRANSMITTERS

A. L205: Requirements

1. The sludge blanket level instrument shall consist of a self-cleaning stainless steel immersion probe element and a transmitter.
2. Probe Components:
   a. Body: Stainless Steel
   b. Wiper: Silicon
   c. Face: Polyoxymethylene
   d. Cables and Power Cord: provide factory furnished length to suit installed conditions.
3. Factory Furnished Accessories:
   a. Mounting Kit
      1) Stainless Steel mounting kit to mount the level indicating transmitter to a wall, 2-inch post and/or railing as required for the installation and as shown on the PLANS.
      2) Stainless Steel mounting kit for the probe shall include Stainless Steel pipe supports, a Stainless Steel 3.3-foot extension pipe, a Stainless Steel hinged pivot, and a Stainless Steel rotating pipe section having a probe protection plate suited to temporarily lift/tilt the probe as required for rotating skimmer applications and as shown on the PLANS.
   b. Replacement Wiper Blades
      1) Package of five (5) replacement wiper blades.
4. The probe shall be equipped with the following:
   a. Magnetic coupled wiper that cleans the probe.
   b. Position sensor that also compensates for angle when the probe is not mounted exactly vertically.
   c. Automatic temperature compensator.

d. Visual performance LED indicator light for assurance of proper performance.

5. Measurement Procedures:
   a. The probe shall define the sludge blanket based on user-selected sludge concentration or "blanket threshold."
   b. The method of measuring sludge level shall be by ultrasonic pulse directed toward the sludge blanket in the tank.
   c. Height and depth measurements shall be based on the time it takes for the ultrasonic echo to return to the probe.
   d. The probe shall be factory calibrated and shall allow users to enter a correction factor.
   e. The probe shall automatically detect deterioration of disrupted sedimentation. It shall sense the ultrasonic echo return with the information of the separation layer independent of density.
6. Performance Requirements:
   a. Measurement range: 0.6 to 40 feet
   b. Measurement interval: 10 to 600 seconds (field adjustable)
   c. Accuracy: ±0.33 feet
   d. Resolution: 0.09 feet
7. Operating Temperature: 35 to 122 degrees Fahrenheit
8. Maintenance Service:
   a. Monthly: Visual inspection, if necessary, clean
   b. Annually: Change wiper blade, or after 20,000 wiping cycles
9. Installation and Programming:
   a. The probe must be installed with the ultrasonic head submerged at least 8 inches.
   b. Program the transmitter and probe to provide a fully functional system.
   c. Coordinate instrument programming parameters including sludge blanket densities and other fluid properties with field conditions and Process ENGINEER.
10. The Indicating Transmitter/Controller shall have the following features:
    a. General: The transmitter shall be a microprocessor-based device capable of functioning with up to two sensors.
    b. Local Indicator: The transmitter shall have a menu-driven operation system, graphical interface unit TFT-LCD outdoor display with capacitive touchpad, UV protection screen, and a real-time clock.
    c. USB Port: The transmitter shall have USB port for data download and controller software upload.
    d. Enclosure:
       1) Rating: NEMA Type 4X, IEC/EN IP 66.
       2) Materials: polycarbonate, aluminum (powder coated), and stainless steel metal enclosure with a corrosion-resistant finish.
       3) Conduit Openings: 0.5 in. NPT.
    e. Interface: The interface unit shall allow operators to control sensor and network functions with menu-driven software. The interface shall include a factory furnished/installed UV protection screen.
    f. Operating Ambient Temperature Range: -4°F to +140°F,
    g. Operating Ambient Humidity Range: 0 to 95% relative humidity, non-condensing
    h. Power Requirements: 120 VAC, 60Hz.
    i. Remote Sensor Inputs:

1) Two (2) digital sensor inputs.
2) Provide analog input in lieu of a digital input if required for each specified sensor.

j. Outputs:
1) Five (5) isolated 4-20mA DC analog outputs with span programmable for each over any portion of the range.
2) Two (2) electromechanical SPDT user configured contacts. Each relay shall comply with the following minimum requirements:
a) Switching voltage: 100 - 240 VAC.
b) Switching current: 5 A Resistive/1 A Pilot Duty.
c) Switching power: 1200 VA Resistive/360 VA Pilot Duty.

k. Certifications:
1) EMC: CE approved (with all sensor types). Listed for use in general locations to UL and CSA safety standards by ETL (with all sensor types).
2) Safety: General Purpose UL/CSA 61010-1 with cETLus safety mark.
3) Possibility for Hazardous Locations Use: Class 1 Div 2.

l. Mounting Hardware: Type 316 Stainless Steel.

11. Each Sludge Blanket Level Element shall be as manufactured by Hach Sonatax sc Sludge Blanket Level Probe with a Hach Model SC4500 transmitter with a digital display screen with specified options and accessories, or Engineer approved equal.

2.09 MECHANICAL LIQUID LEVEL SWITCHES

A. L411: Requirements
1. The Non-metallic tilting Float Level SPDT Switch with non-metallic tilting float shall have the following features.
2. Float Construction: Corrosion resistant PVC
3. Certification: U. L. Listed, suitable for suspension mounting as shown on the PLANS
4. Switch:
a. Normally open hermetically sealed.
b. Mounted integrally with float and mechanically activated with float position.
c. Opens or closes on the level condition as described on the PLANS. Refer to the PLANS.
d. Single-pole-double-throw (SPDT) and rated 13 Amp inductive load at 120VAC.
e. Switch shall not contain mercury.
5. Cable Connection:
a. Flexible 14 AWG, 3-conductor SJOW-A water resistant cable integrally connected to float body.
b. Of sufficient length to be routed without any splice to the cable termination box as shown in PLANS.
c. Coil a minimum of 4 feet of slack of level switch cable within the cable termination box.
6. Weight:
a. Field moveable weight installed on the cable for level adjustment.
b. Float is to have a minimum “SET-RESET” level differential angle of 85-degrees (plus or minus 5 degrees).

c. Weight shall be made of corrosion resistant material.

7. Mounting:
   a. Provide all necessary mounting hardware for a secure installation of level switch complete with all accessories.
   b. Comply with the additional requirements as shown on the PLANS.
8. Each level switch shall be as manufactured by “SJ Electro Systems, Inc.” Series SJE Pump Master SPDT with “S.J. Electro Systems, Inc.” liquid-Tight round cable connectors (one per float) and S.J. Electro Systems complete Cable Weight Assembly or Engineer approved equal.

2.10 HYDROGEN GAS ANALYZER AND INDICATING TRANSMITTERS

A. A105: Requirements
   1. General:
      a. Furnish gas analysis and indicating/transmitter for the detection of Hydrogen gas concentration and with integral auxiliary high-high and fail alarm relays.
      b. Measure combustible gas concentrations using poison-resistant catalytic bead type sensors.
      c. Provide in a dual condulet version to allow the sensor only to be mounted near the ceiling while the transmitter display and controls are mounted near finished floor.
         1) Field installed flexible tubing shall be permanently installed to allow calibration gas to be fed to the sensor from the transmitter location.
      d. Sensor Type/Personality: Electrochemical (EC).
      e. The sensor module and the indicator/transmitter module shall be the product of the same manufacturer.
   2. Indicating/Transmitter Module:
      a. General Performance:
         1) Four-wire loop
         2) Shall operate from power supplies of 24 VDC, 1,000 mA maximum.
         3) Response Time: (T90) 90 seconds.
         4) Accuracy: +/-8 ppm of measured value.
         5) Operating Temperature: -40 to +149 degrees Fahrenheit.
      b. Local Indicator:
         1) LCD local indicator (integral to gas Indicator/Transmitter).
         2) Range: 0-1,000 ppm.
      c. Operator Local Controls:
         1) Provide operational interface for service personnel
         2) Four (4) minimum controls to allow configuration and calibration functions.
      d. Transmitter Output:
         1) 4-20 mAdc insulated analog output linear to gas concentration.
         2) Capable of driving external loads up to 500 ohms with a standard 24 VDC supply.
         3) Electrically isolated from ground and from all other internal circuits that are not isolated from ground.
         4) Output isolation shall be provided by the transmitter.
      e. Alarm Relays:
         1) Three (3) form “C” SPCO contacts, two for alarm and one for fault indication, and each rated for 5 A at 250 VAC.

2) Relay coil programmable either normally energized or normally de-energized.
3) Alarms field programmable for Setpoint, Hysteresis, Alarm delay, Manual or automatic reset, and Instrument fault.
4) Configure the hydrogen concentration alarm contact that is wired/active such that it alarms at and above 980 ppm hydrogen concentration measurement.

f. Instrument Enclosure:
1) Housed in LM25 Aluminum, painted explosion-proof enclosure with window.
2) Shall include 3/4” NPT UL/CSA threaded cable/conduit ports as required for connections as shown on the PLANS. Provide factory furnished plugs for all unused connection ports.
3) Transmitter and sensor shall be UL Classified, FM Approvals Listed, and CSA Listed and shall meet specifications for Class I, Div. 1 Groups B, C & D Class I, Zone 1 Groups IIB + H2; Class II, Div. 1 Groups F & G, Class II, Zone 20 & 21.

3. Remote Sensor Mounting:
a. Remote sensor mounting shall allow the instrument sensor to be remotely mounted via a 50 foot cable from the transmitter.
b. Provide shielded cable, cable glands, and remote terminal box as required for a complete functional installation.

4. Remote Gassing Accessories:
a. Furnished factory accessories to enable gas to be applied remotely for performing functional response checks; bump tests.
b. Provide 50-feet of factory furnished 1/4" interior diameter (ID) PTFE (Teflon) tubing, a mounting bracket, a tube cap, and device adapters in 1/4” and 1/8” ID to attach to bump test ports on the weatherproof cap of the device.

5. Furnished with the following manufacturer accessories:
a. Sensor Weatherproof Cap: Provide factory furnished weatherproof cap and sensor retainer to protect sensor. Weatherproof cap shall also include remote gassing bump test port to connect flexible PTFE (Teflon) tubing to allow the remote gassing of the sensor.
b. Sensor Collecting Cone: The collecting cone shall improve detection of lighter-than-air gases such as hydrogen.
c. Support Hardware/Brackets: Provide all required accessories including hardware/brackets for pipe-mount or wall/ceiling to mount transmitter and sensor. Refer to PLANS for additional requirements.

6. Gas Calibration Kit:
a. As minimum, the gas Calibration Kit shall include the following:
1) One (1) 103-Liter non-disposable gas aluminum cylinder filled with 500 ppm concentration of HYDROGEN to air calibration gas.
2) Inert tubing Tygon 3/16 in. ID x 5/16 in. OD FEP lined; 5 feet minimum length.
3) Pre-set 0.3 liters per minute flow regulator.
4) Mechanical Valve and Flowmeter assembly (inclusive of mechanical gauge) suitable for use with the gas cylinder.
5) Calibration cup flow adaptor.
6) Hard brief-case type calibration case made specifically for housing the cylinder, mechanical valve and flow regulator assemblies,

calibration cup, inert tubing, and all that is associated with the Calibration Kit.

b. The Calibration Kit shall be the product of the same manufacturer as the gas indicator/transmitter module and the sensor module.

7. Each Indicator/Transmitter module shall be as manufactured by Honeywell Analytics Series XNX EC model XNX-UTAE-R model Universal Gas Transmitter with HYDROGEN Gas Sensor model XNXXSG1SS, Collecting Cone model S3KCC, Remote Mount Sensor Kit model S3KRMK, Remote Gassing Kit model 1226A0354, Gas Calibration Kit model XNXTOXKit and gas cylinder model 1991-0159 or Engineer approved equal, complete with the specified accessories.

2.11 WEIGHT MEASUREMENT ELECTRONIC LOAD CELL AND INDICATING TRANSMITTERS

A. W105: Requirements

1. General:
   a. The Weighing Systems shall be utilized for measuring storage containers, including intermediate bulk container (IBC) units.
   b. CONTRACTOR shall coordinate container dimensions, weights, support structure configuration and dimensions with the Weighing System manufacturer to assure a complete and functioning Weighing Systems.
   c. Each Weighing Systems shall be furnished with Scale and Indicator/Transmitter, manufacturer-supplied cables and with accessories specified herein and mounted as shown on the PLANS.
   d. Manufacturer supplied cables shall be furnished for connections from the Scale to the Weight/Indicator Transmitter.
2. Each Scale Assembly shall have the following features:
   a. Quantity of Load Cells: Provide four load cells; one located at each corner of the scale platform.
   b. Load Rating Capacity of Load Cell Assembly:
      1) Capacity of Scale Assembly shall equal the sum of individual load cells and shall be rated for the maximum weight of fully loaded container.
      2) Refer to the “Instrument List” for weight span of Scale Assembly. Provide scale from approved series to provide greatest precision within listed Load Cell Assembly weight span.
   c. Cable: Manufacturer-supplied cable for termination at a manufacturer supplied Indicator/Transmitter. Provide length required for installation.
   d. Construction:
      1) Steel frame; dry powder polyester plastic coated.
      2) Solid 1/2 inch thick PVC decking
      3) All hardware shall be stainless steel.
   e. Scale Height: 3.5 inches or less.
   f. Scale Footprint: 48-inches by 48-inches.
   g. Electrical Connection: 1/2" Conduit NPT at summing box; integral to scale. Summing box shall be located on the underside of the scale.
   h. Load Cells:
      1) 4 NTEP approved stainless steel shear beam cells.

2) Four (4) cell system shall be provided and shall be designed to allow for accurate reading when loads are placed off-center anywhere on the base.

i. Leveling Feet: Stainless Steel

3. Each Weight Indicator/Transmitter shall have the following features:
   a. Indicator shall have two (2) separate displays each recessed/mounted onto to the face of the indicator/transmitter unit as follows:
      1) A two (2) line 16 character LCD display, backlit to display menu and functions.
      2) A one (1) line large LED display with 0.56-inch high digits to show numeric result.
   b. Housing:
      1) NEMA 4X,
      2) UL approved
   c. Channels: Single Channel
   d. Power: 120 VAC, 0.5 Amp.
   e. Electrical Connections: Housing designed for filed-cut conduit connections.
   f. Output Signal: 4-20 mA. Output signal shall be powered via the transmitter. Loop power signal is not acceptable. Provide 24 VDC supply/transformer inside transmitter enclosure as required to comply.
   g. Operating Temperature: 32 to 120 degrees Fahrenheit.
   h. Span: Capable of 0.1 lb. or 0.1 kg up to 9999.0 lbs. or kg.
   i. Accuracy: 0.5% of full scale, or better.
4. Each Weigh System, inclusive of Scale Assembly and Weight Indicator/Transmitter, and all other required accessories shall be furnished by the same manufacturer. Each Weighing System shall be as manufactured by Scaletron Industries with Scaletron Industries Model 4040-IBC scale and Scaletron Model 1099 Display Weight Indicator/Transmitter, or Engineer approved equal.

2.12 DIGITAL LOOP POWERED INDICATORS

A. I107 Requirements
   1. Display:
      a. 3 and 1/2 digit, 1.0 inch high bright Liquid Crystal Display (LCD).
      b. Watertight/gastight and corrosion resistant lens that will enable reading the indictor display without opening any cover door of the indicator's enclosure/housing.
   2. Input Signal:
      a. 4-20mA at 24VDC
      b. Signal proportional to the process variable measured.
   3. Units:
      a. Calibrated in engineering units (applicable to the specific system and measured variable) in order to indicate and control the process variable in the same units (i.e., GPM/MGD for Flow, Inches/Feet for Level, PSI for Pressure, °F/°C for Temperature, etc.).
      b. The engineering units shall be permanently marked on the surface of the indicator.
      c. Refer to the “Instrument List” for additional information.

4. Readout Accuracy: Plus or minus 0.1 percent of calibrated span plus or minus 1 count.
5. Calibration Range:
    a. 4 ma input: -1000 to +1000 display.
    b. 20 ma input: between 20 to 2000 counts greater than 4 ma display.
6. Voltage Drop: 1 VDC maximum at 20 mA.
7. Conversion Rate: 2.5 conversions per second.
8. Calibration:
    a. Two-step, non-interacting zero and span.
    b. Indicator and enclosure assembly zero and span adjustment shall be external to the indicator housing/enclosure such that zero and span shall be adjusted externally without opening any cover/door of the indicator's enclosure/housing.
9. Enclosure:
    a. NEMA 3, 4, 7 and 9 rated.
    b. Corrosion resistant and watertight/gas-tight.
    c. Explosion-proof cast aluminum housing.
    d. FM approval.
10. Nameplate: Each indicator shall be equipped with an engraved nameplate that will display the total range of the indicator. This information may be incorporated on the instrument identification nameplate.
11. Operating Temperature: -40 to +176 degrees Fahrenheit.
12. Power: Two-wire loop powered.
13. Wiring Connections:
    a. 3/4" NPT male conduit hub connection.
    b. Terminal block inside enclosure.
14. Mounting: Manufacturer furnished Type 316 Stainless Steel mounting bracket kit and as required for installation shown on PLANS.
15. Each Indicator shall be as manufactured by Precision Digital Model PD6870 complete with specified accessories or Engineer approved equal.

2.13 TUBING, HAND VALVES AND FITTINGS

A. General: Refer to the PLANS for additional requirements for tubing, hand valves, fittings, etc. Provide tubing, hand valves, and fittings for pressure and differential pressure instruments and devices as shown. Provide as required for a functional installation.

B. Tubing:
    1. Material: ASTM A-213 Type 316 Stainless Steel annealed seamless
    2. Size:
        a. Indoor (Inside Building): 3/8” outer diameter tubing with 0.049” wall thickness
        b. Outdoor (Outside of Building): 1/2” outer diameter tubing with 0.049” wall thickness
        c. Stand Pipe Ventilation or Other System Ventilation Piping: 1” outer diameter tubing with 0.109” wall thickness.
        d. Provide other larger size(s) as shown on the PLANS.
    3. Pressure Rating: 3,000 psi minimum working pressure at 100 degrees Fahrenheit

C. Valves and Fittings:
   1. Manufacturer: Crawford “Swagelok”, Hoke “Gyrolok”, or Parker “CPI”.
   2. Metal fittings and Accessories:
      a. Type: Swage ferrule design
      b. Material: Type 316 Stainless Steel
      c. Size: Same size as tubing
      d. Pressure Rating: Same as tubing
   3. Valves:
      a. Type: Full port ball valves
      b. Material: Type 316 Stainless Steel trim and body
      c. Connection Type, Both Ends: Swage ferrule design
      d. Seats and packing: Teflon
      e. Size: Same size as tubing
      f. Pressure Rating: Same as tubing
   4. Bleed Fitting/Valve:
      a. Type: Swage ferrule or threaded process connection, as suited for application. Include vent tube and back stop screw. Provide handle. Provide barbed ventu tube where vent tube is piping to drain or other location where shown on PLANS.
      b. Material: Type 316 Stainless Steel
      c. Stem O-Ring: Fluoroelastomer.
      d. Size: Same size as tubing
      e. Pressure Rating: Same as tubing
   5. Provide stainless steel reducer/transition fittings at instrument/process piping and tubing connections.
   6. Bulkhead Fittings:
      a. General Requirements:
         1) Material: Type 316 Stainless Steel trim and body
         2) Size: Same size as tubing
         3) Pressure Rating: Same as tubing
      b. Tubing to Tubing Unions:
         1) Fitting: Bulkhead Union, Hoke BU or Engineer approved equal.
         2) Connection Type, Both Ends: Swage ferrule design
      c. Tubing to Test Port:
         1) Fitting: Bulkhead Union, Hoke BU or Engineer approved equal.
         2) Connection Type, Both Ends: Swage ferrule design
      d. Tubing to Vent Screen Fitting:
         1) Fitting: Bulkhead Union, Hoke BU with or Engineer approved equal.
         2) Tubing Connection Type: Swage ferrule design with standard nut.
         3) Screen Connection Type: Swage ferrule design with knurled nut, Hoke KN or Engineer approved equal.
   7. Vent Screen Fittings:
      a. Material: Type 316 Stainless Steel trim and body
      b. Size: Same size as tubing or pipe vent screen fitting is connected to.
         1) Available vent screen fitting sizes shall include 1/4", 3/8”, 1/2”, 3/4", and 1” in diameter.
         2) Vent screen fitting shall be of equal diameter or the next listed size greater than the tubing/piping the vent screen fitting is connected to.
         3) Provide reducer fitting between vent screen fitting and tubing/piping as required.

4) Where tubing/piping is larger than 1” diameter, provide 1” size vent screen fitting and necessary reducer fitting to connect to tubing/piping.

c. Pressure Rating: Same as tubing

d. Fitting: Screen, Hoke SCRN or Engineer approved equal.

8. Provide stainless steel rigid to plastic flexible tubing transitions where shown on PLANS including stainless steel tube inserts and Teflon ferrule compression fitting.

D. Tubing Support System:

1. UNISTRUT Cush-A-Clamp Assembly Pipe/Tube Clamp (1-5/8" Series), or Engineer approved equal, with controlled squeeze shoulder bolt for all clamping of instrument tubing.
2. Refer to Specification Section 16150 “Raceways, Fittings, and Supports” for instrument tubing support channel system additional requirements.

2.14 WIRE MESH GRIPS

A. General: Furnish and install heavy duty wire mesh grip to support suspended floats, transducers, etc. as required. Refer to the details shown on the PLANS. Coordinate size of mesh grip required with cable to be supported. Mesh grip shall have the following features:

1. Material: Type 316 Stainless Steel
2. Breaking Strength: 1000 lbs, minimum
3. Manufacturer: Hubbell-Kellems “Heavy Duty, Single Eye, Closed Mesh, Multi-Weave” model series 024170xx, where “xx” is adjusted according to cable diameter. Coordinate cable diameter with the PLANS.

2.15 CABLE HANGERS

A. Where PLANS show a cable (or rope) hanger or hook mounted on wall, provide the following cable hanger:

1. Cable hanger shall be entirely made of Type 316 Stainless Steel material/construction.
2. Cable hanger shall be suitable for mounting onto wall, with manufacturer pre-drilled holes for hanger mounting.
3. Cable hanger shall have six (6) cable hooks, where each hook shall be minimum 3/8” diameter rod of 316 stainless steel material that is shaped into the form of a hook intended for hanging heavy duty material. Each such hook shall be integrally and permanently attached to the cable hanger.
4. The cable hanger assembly shall be approximately 24” wide by 9” high.
5. Mount cable hanger as shown on PLANS. All mounting hardware shall be of Type 316 Stainless Steel material/construction.
6. Furnish and install Cable hanger for each Submersible Level Transducer and Transmitters and each Mechanically Activated Level Switch, as shown on PLANS. Refer to mounting of devices, as shown on PLANS.
7. Where multiple Submersible Level Transducers and Transmitters and/or Mechanically Activated Level Switches are located in the same location, then one (1) common cable hanger may be used for up to three (3) such devices. Where multiple devices are assembled on the same cable hanger, space out the devices such that they do not interfere with one another. Furnish and

install additional cable hangers, as required, to assure devices do not interfere with each other.

8. Mount the cable hanger away from wall so as not to touch/interfere with wall. Furnish and install additional structural support channel, as required, so as to distance the devices from the wall and assure devices do not touch/interfere with wall.
9. Cable hanger shall be the “Cable Holder” product as manufactured by U.S.F. Fabrication, Inc.

B. Where PLANS show a cable (or rope) hanger or hook mounted on the underside of a blind flange or on a support channel, provide the following cable hanger assembly elements:
   1. Cable hanger assembly elements shall be entirely made of Type 316 Stainless Steel material/construction.
   2. The cable hanger assembly shall consist of a steel swivel eye hook that shall be fastened onto/through a U-bolt. The U-bolt shall be fastened via nuts and washers to the overhead blind flange or support channel shown on the PLANS.
      a. The U-bolt shall be a M10 x 2.125 inch Steel U-Bolt constructed of Type 316 Stainless Steel 0.35 inch minimum diameter rod that is bent to allow 1.62 inch minimum clear space between the U-bolt rods, and each rod having a 2.125 inch minimum length of threaded section. The U-bolt shall be as manufactured by HAAS Stainless, part number 51611884, a division of Sea-Land Distributors, LLC, or Engineer approved equal.
      b. The swivel eye hook shall be constructed of Type 316 Stainless Steel, have an eye diameter of 0.5 inches minimum, have a spring loaded latch, and a load capacity of 3,306 pounds, minimum. The swivel eye hook shall be 1/2” Stainless Steel Swivel Eye Hook with Latch, as manufactured by HAAS Stainless part number 51606320, a division of Sea-Land Distributors, LLC, or Engineer approved equal.
   3. Mount cable hanger as shown on PLANS. All mounting hardware shall be of Type 316 Stainless Steel material/construction.

C. Where PLANS show a cable thimble for a cable (or rope), the thimble shall be constructed of Type 316 Stainless Steel and shall accommodate a 0.5 inch minimum diameter rope/cable. The thimble shall be a 1/2” Stainless Steel heavy duty wire rope thimble, as manufactured by HAAS Stainless part number 51605020, a division of Sea-Land Distributors, LLC, or Engineer approved equal.

2.16 HOODS (SUN-SHIELDS)

A. Furnish and install an aluminum HOOD (Sun-Shield) on top of each Enclosure/Panel, Indicator Instrument, Transmitter Instrument, Indicating/Transmitter Instrument, Analyzer Instrument, Controller Instrument, Instrument Element and Field Control Station that is mounted OUTDOORS and/or mounted within/below a vault/structure such that it receives direct sunlight through an opening in the vault/structure:
   1. Where the term Sun-Shield is used on the PLANS and specifications, it shall imply HOOD as noted herein.
   2. Aluminum HOOD installation shall apply for all field instrumentation installed OUTDOORS, inclusive of field instrumentation specified in this Section and

specified in other applicable portions of the PLANS and specifications to be provided as part of this Work, including, but not limited to, Divisions 11, 13, 15, 16 and 17 Specification Sections as applicable, other equipment specifications sections including instruments specified or provided by equipment manufacturers, and/or as shown on the PLANS.

3. Support the HOOD via channel supports that are separate from and independent of the instrument, instrument flange mounting assembly and/or instrument support channels/rack/pipe. Secure the HOOD to the support channels utilizing 316 Stainless Steel hardware. Provide all mounting hardware necessary for the installation of the Hood Assembly. Refer to the PLANS.
4. HOOD shall be a fabricated component and shall be fabricated from minimum 0.1" thickness, aluminum alloy 3003-H14 sheet (ASTM B209). All seams or joints of HOOD shall be closed by continuous weld except where a mechanical hinge is noted.
5. The top of the Hood shall clear the top of the associated instrument/enclosure/panel by 6 inches. The side visors of the Hood shall clear both sides and rear of the associated instrument/enclosure/panel by 6 inches.
6. Furnish and install a hinged front flap/cover on the HOOD to protect the front (full height and width) of the instrument/field control station inside the HOOD. The flap shall extend down from the top hinge to the bottom of the proposed instrument/field control station at minimum, but shall not extend beyond the bottom of HOOD assembly. The flap shall swing up through a full 180-degree of rotation. Secure the flap to the front of the HOOD with a continuous aluminum piano hinge that is welded via a continuous aluminum weld to the HOOD and welded via a continuous aluminum weld to front flap/cover. The piano hinge shall be constructed of 0.09-inch thick minimum 3003-H14 sheet (ASTM B209) aluminum, having a 2-inch minimum open width, a length as required for the full width of the HOOD and flap/cover and manufactured by Monroe of Rochester Hills, Michigan or Engineer approved equal.
7. Provide a mock-up of the HOOD (Sun-Shield) as follows for review by the OWNER and ENGINEER:
    a. Upon completion of the review and comment of the HOOD (Sun-Shield) shop drawing(s) by the OWNER and ENGINEER, fabricate and submit a mock-up of a complete HOOD (Sun-Shield) assembly for additional review and comment by the OWNER and ENGINEER prior to fabricating the required quantity of HOODS (Sun-Shields) to be installed as part of this Work.
    b. The size of the mock-up shall be based on an instrument or field control station/panel that is 6-inches wide, by 6-inches tall, and by 4-inches deep.
    c. The HOOD (Sun-Shield) mock-up shall be in addition to the quantity of HOODS (Sun-Shields) to be installed as part of the final Work as required per the specifications, the “Instrument List” and/or as shown on the PLANS.
    d. The following elements are not required as part of the mock-up:
        1) The instrument and/or control station/panel to be installed inside the HOOD (Sun-Shield).
        2) The support elements/channels on which the HOOD (Sun-Shield) is fastened as shown on the Drawings.

e. Refer to the mock-up requirements in this section for additional requirements.

B. Refer to PLANS for additional requirements for construction and mounting of HOOD.

2.17 STAND-PIPES

A. Where PLANS show a stand-pipe (also referred to as a stilling-well), provide the following pipe, flange and blind flange components:
   1. General Indoor and Outdoor Applications:
      a. The stand-pipe shall be an ASTM B 221 Type 6061-T6 Schedule 40 Extruded Aluminum Pipe of diameter and length as shown on PLANS.
      b. Provide a Type 6061-T6 Aluminum Flange Class 150 psi per ANSI B16.5 with full aluminum slip-on or weld-neck welded connection to pipe. Flange diameter to match stand-pipe diameter shown on PLANS.
      c. Provide a 6061-T6 Aluminum Blind Flange Class 150 psi per ANSI B16.5 with Type 316 Stainless Steel bolts, washers, and nuts hardware assembly to fasten blind flange to flange fitting. Pipe flange and blind flange bolt patterns shall match. Blind flange cap diameter to match stand-pipe diameter shown on PLANS.
      d. Fabricate two (2) handles made of the same material as the blind flange and welded to the top face of the blind flange. Refer to the PLANS for additional requirements, including blind flange handle geometry.
   2. Stand-pipe mounting hardware and support brackets shall be manufactured from Type 316 Stainless Steel. Refer to the details on the PLANS.

2.18 SUPPORT SYSTEMS CONSTRUCTED OF PIPES AND PIPE FITTINGS

A. Where pipes are shown on the PLANS as support elements in lieu of support channels, the pipe and pipe fitting components of the support systems shall be Type 316L Stainless Steel with welded joints and constructed as follows:
   1. Materials of Construction: Type 316L Stainless Steel. All Stainless Steel Sheet and Plate shall be extra low carbon (0.03% maximum) and meet ASTM/ASME standards. All welding shall conform to material requirements.
   2. Finish: Number 1 Hot-Rolled Annealed and Pickled. After all shop operations have been completed, all stainless steel material shall be pickled and passivated (completely immersed for a minimum of 15 minutes in 10% nitric acid and 3% hydrofluoric acid at 125˚F, followed by a neutralizing rinse).
   3. Wall Thickness: Schedule 40S per ASTM A-312/ASME SA-312.
   4. Welding: All welding shall be per GTAW, GMAW and plasma arc welding processes. All welders shall be ASME qualified welders and shall use ASME procedures designed to provide full penetration welds. Automatic or semi-automatic positioning fixtures shall be used on pipe and fittings. Interior surfaces shall be smooth, even and uniform.
   5. Pipe: All pipe elements shall conform to ASTM A-778, A-312, A-358, A-269 or A-249 specifications unless otherwise noted.
   6. Fittings: All pipe fittings shall conform to ASTM A-403 or A-774 specifications unless otherwise noted. Fittings shall conform to ANSI B16.9/MSS SP 43 requirements. Applicable fittings include, but are not limited to:
      a. 90 degree elbows,

b. 45 degree elbows,
c. 45 degree laterals,
d. Tees and wyes,
e. Reducers, and
f. Caps.

7. Dimensions: Applicable elements shall be manufactured to MSS dimensions.
8. Marking: All pipe and fittings shall be marked in accordance with the requirements of the pertinent ASTM/ASME standard.
9. Manufacturer Quality Program and Certifications: The pipe and fitting manufacturer quality system shall be registered to the ISO 9001 standard and shall have an ANSI/ANAB accredited third party auditor. The quality program shall utilize, as a minimum, the following inspection and test methods:
   a. Liquid penetrant,
   b. Eddy current,
   c. X-ray, and
   d. Hydrostatic.
10. Shipping: Materials shall be crated. All plain ends shall be plugged and flanged ends shall be wired to protect lap ring surface.
11. Flanges: Shall be solid Type 316L Stainless Steel per ANSI B16.5 and ASTM A182F, forged slip-on welded onto the pipe/fitting at the factory, flat faced, and 150 pound class pressure rating unless noted otherwise.
    a. As an option to the fabricator, flanges may be weld-neck butt-welded in lieu of slip-on welded.
    b. Provide raised faced flange in lieu of flat faced when required for a specific valve/equipment connection.
    c. Flange face shall be machined smooth to accept gasket.
       1) Serrated face flanges are NOT acceptable.
       2) Angle face rings and backer flanges are NOT acceptable.
12. Hardware and gaskets: Type 316 Stainless Steel bolts, washers, and nuts of sufficient size and construction suitable for the class pressure rating on the flange which hardware is installed in accordance with ANSI B16.5 requirements.

B. Pipe and fitting components shall be as manufactured by Felker Brothers Corporation with all specified options and accessories, or Engineer approved equal.

PART 3 EXECUTION

3.01 STORAGE AND HANDLING

A. The field instrumentation and control devices shall be handled carefully to prevent damage. Units shall be stored in a weatherproof structure prior to installation.

3.02 INSTALLATION

A. General: The following apply to all products in this Section:
   1. Furnish and install devices in locations shown, and per the details provided in the PLANS, unless otherwise noted.
   2. Unless otherwise specified, all instrument mounting channels, pipes, pipe caps, etc. shall be Type 316 stainless steel; also, all hardware connecting and

securing the mounting hardware and instruments such as nuts, bolts, cush-a-clamp assembly pipe/tube clamp, all instrument tubing channels and their support elements, etc. shall be Type 316 Stainless Steel. Refer to Division 16 Specifications for additional support system requirements.

3. All field mounted sensor/control/instrument devices shall be permanently identified. The device designations shall agree with those shown on the PLANS. Each device shall be provided with permanent type identifying nameplate. Nameplates, unless otherwise specified, shall be shaped as a circle and shall be constructed of 3-ply "White-Black-White" laminated phenolic material having engraved letters approximately 1/4 inch high extending through the white face into the black layer. Securely hang nameplates from each sensor/control/instrument device by a flexible stainless steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).
    a. All proposed instruments shall receive new permanent identification.
    b. All existing instruments shown on the PLANS that are to be relocated and/or to receive new wiring for signals/power/etc. as part of this Work shall also receive new permanent identification. Remove the existing identification tags from existing instruments that are to receive new tags.
4. Nameplates:
    a. Type: 3-ply, 1/8" thick, rigid thermoset phenolic resin laminated cellulose paper base engraving stock per ASTM D-709, Type I. Nameplates shall be ASTM Grade ES-1, ES-2, or ES-3 as applicable for the face and lettering colors specified hereinafter. Flexible or acrylic tags will be not be accepted.
    b. Color: White-Black-White
    c. Lettering: 1/4 inch height, minimum, engraved through the face layer to the melamine middle layer.
    d. Accessories: Provide holes for mechanical fastening.
    e. Attachment Means: Securely hang nameplates from each sensor/control/instrument device by a flexible stainless steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).
    f. Each nameplate inscription shall at minimum consist of the instrument tag, then followed by an instrument description as listed in the Instrument List or other description source per the PLANS and/or Specifications, and then the unit of measure. The unit of measure shall be placed in parentheses. Locate and orient nameplate so that it is easily and readily identifiable by Owner.
5. Install, set, adjust and test all devices per the requirements of Section 17100 of the Specifications. Also, setpoint values shall be reviewed by and coordinated with the OWNER/ENGINEER.
6. The pressure instruments specified under this Section of the Specifications shall be tested by applying known pressure to each unit prior to installation.
7. The instruments specified under this Section of the Specifications shall be installed and calibrated to match its respective system and per the requirements of the Contract Documents and as recommended by the manufacturers.
8. Verify ranges with Owner and Engineer prior to ordering instruments.
9. Refer to Specification Section 16150 "Raceways, Fittings, and Supports" for instrument support channel system requirements.

10. Make all final connections and terminations per the instrument manufacturers' recommendations.
11. Unit and Range of each instrument shall be as listed in the "Instrument List" and shall be clearly noted on the instrument Submittals. Instrument ranges shall be confirmed via the submittal process with the ENGINEER prior to ordering any of the Field Instrumentation and Sensing Devices specified under this Section of the Specifications. Select instruments within approved manufacturer series that provide the greatest level of accuracy within the span of measurements listed in the "Instrument List".
12. Submit comprehensive calibration sheets to the OWNER indicating "as found" and "final settings". Submit a typical (blank) field calibration sheets/forms to the OWNER for review and comment prior to utilizing the same for recording calibration parameters. Include final field calibration settings in the Operation and Maintenance Manuals.
13. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.
14. Provide manufacturer's services to perform start-up and calibration/verification.
15. Verify factory calibration of all instruments in accordance with the manufacturer's instructions. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.
16. Furnish and install an aluminum HOOD (Sun-Shield) on top of each Enclosure/Panel, Indicator Instrument, Transmitter Instrument, Indicating/Transmitter Instrument, Analyzer Instrument, Controller Instrument, Instrument Element and Field Control Station that is mounted OUTDOORS and/or mounted within/below a vault/structure such that it receives direct sunlight through an opening in the vault/structure. Refer to the PRODUCTS PART 2 Section of this specification and the PLANS for additional requirements on the construction and installation of each HOOD.
17. Where piping is provided as a support element in lieu of support channels, including, but not limited to, 2-inch diameter pipe posts, all open ends of piping shall be capped with a welded cap having the same material and diameter as the piping. Refer to the PRODUCTS PART 2 Section of this specification and the PLANS for additional requirements.
18. For each instrument specified in this section that includes an integral display screen/indicator and/or user interface button(s), unless indicated otherwise on the Drawings, install the instrument such that the top of the display screen/indicator and/or user interface button(s) is as high as possible but no greater than 60 inches above the finished floor of the working area immediately adjacent to the instrument. Refer to the Drawings for additional requirements. Refer to additional installation height requirements for each specific instrument as specified in this section.
    a. Note: For each instrument that includes an instrument tubing connection, refer to the applicable instrument tubing installation requirements in this section for the required slope of the instrument tubing and other additional requirements that impact the installed height of the instrument.
19. For instruments with a fail status contact, the contact shall be open on instrument diagnostics fail condition or power fail condition and shall be closed otherwise. Refer to the PLANS for additional requirements.

B. Pressure Instruments (Inclusive of Multivariable):
   1. Testing:
      a. The pressure instruments specified under this Section of the Specifications shall be tested by applying known pressure at 0%, 50% and 100% minimum increments of span to each unit prior to installation.
   2. Pressure Indicating/Transmitters Serving Liquid Process Lines:
      a. Install instruments with instrument tubing such that the elevation of pressure tap(s) on transmitter bottom works is 3" minimum below the elevation of the pressure tap(s) on the process piping/flow-tube element (i.e. venturi, orifice plate, etc.) served and all instrument tubing is above the transmitter bottom works pressure tap(s) and sloping up towards the pressure tap(s) of the process piping/flow-tube element served.
         1) Exception: Pressure instruments with diaphragm seals can be installed above the pressure taps of the process piping/flow-tube element served. However, all piping between the diaphragm seal and the process pipe shall be horizontal.

C. Ultrasonic Level Element and Indicating/Transmitters:
   1. Position and orient instrument beam as required for optimal and most accurate level measurements for well/tank/container application and to reduce interference from side walls of wells/tanks/containers.

D. Level Switches:
   1. Coordinate with Owner and process/mechanical for all level switch elevation requirements prior to installation.
   2. Furnish and install dedicated terminal junction box for termination of level switch wiring and interconnection to the field interconnect conduit/wire per the details shown on the PLANS.

E. Submersible Level Transducers:
   1. Coordinate with Owner and process/mechanical for all level elevation requirements prior to installation.

F. Hydrogen Gas Analyzer with Remote Mounted Indicating/Transmitters:
   1. Indicating/transmitter shall be remote mounted separate from sensor.
   2. Sensor shall be mounted as high as possible in the room and at least within 6" below highest roof deck of space.
   3. Provide cable and conduit between sensor and transmitter.
   4. Provide raceway system and required cable per instrument sensor factory requirements between sensor junction box and remote mounted indicating/transmitter.

G. Weight Scale and Indicating/Transmitters:
   1. Provide 6 foot length minimum of flexible conduit connection at weight scale connection and install in a manner to not provide stress on the scale such that to cause error in measurement.
   2. Install in strict accordance to manufacturer requirements. Provide neatly cut holes in indicator/transmitter housing for connection to scale, power connection, and signal connection, each. Refer to PLANS.

H. Instrument Tubing: Gas, Liquid, and Capillary Tubing
   1. Install tubing and supports so as not to interfere with work space/maintenance access of existing and proposed equipment.
   2. Make all instrument tubing system connections air/water tight. Provide proper thread/joint sealant such as Teflon brand strips or other approved sealant where connecting to equipment/accessories/fittings.
   3. Requirements herein relate to process pressure port taps/connections shall apply to flow-tube element (i.e. venturi, orifice plate, etc.)connections as well.
   4. Tubing Support Systems (for Flexible Capillary and Rigid Tubing):
      a. Support all instrument tubing by channel support systems. As a minimum, support all instrument tubing as follows:
         1) Gas and Liquid Tubing: Clamp tubing onto channel support systems with tubing clamps spaced at no greater than 2'-6" intervals on horizontal and vertical runs, and no greater than 3" from each instrument tubing elbow and tee fitting.
         2) Capillary Tubing: Route capillary tubing inside channels.
            a) After installing the tubing in the open channels, cover as much of the open face of the channels as possible with segments of 1/8" thick cover plates constructed of the same material as the channel. Each cover plate shall be cut to 23 inches maximum in length, and the width of the plate shall match the width of the channel. Secure the cover plates to the channels with channel hardware and fittings.
            b) Refer to the PLANS for additional capillary channel requirements.
         3) Refer to the PLANS for additional support requirements.
      b. Provide suitable floor mounted or ceiling hung channel support systems necessary for mounting/fastening of instrument tubing.
      c. Overhead or wall support systems for tubing shall be independent of other conduit/pipe support systems and shall solely support instrument tubing systems.
   5. Instrument Tubing Conveying Liquid:
      a. Pressure port tubing connections to process piping and flow-tube elements shall be installed on the side (spring line) of horizontal process pipes and flow-tube elements.
      b. Horizontal runs of tubing installed lower than the process pipe/equipment tap connection shall be sloped 10% up towards the process pipe/equipment connection.
      c. Tubing installed higher than the process pipe/equipment tap connection shall have a vent valve installed at its highest point. Slope tubing 10% up towards valve. Provide additional vent valves at highest points/segments of instrument where air/gas can accumulate.
         1) Note:
            a) Instrument tubing serving pressure indicating/transmitter having no diaphragm seal shall not be installed above the process pipe/equipment tap connection. Refer to pressure indicating/transmitter installation requirements.
      d. Do not install instrument tubing conveying liquids directly over electrical panels/equipment. Provide a 3'-0" distance, as seen in plan view, between liquid filled instrument tubing and electrical power distribution equipment.
   6. Instrument Tubing Conveying Air/Gas:

a. Pressure port tubing connections to process piping and flow-tube elements shall be installed on the top crest position of horizontal process pipes and flow-tube elements.
b. Horizontal runs of tubing installed higher than the process pipe/equipment tap connection shall be sloped 10% down towards the process pipe/equipment connection.
c. Tubing installed lower than the process pipe/equipment tap connection, shall have a condensate drip leg and drain valve. Drip leg pipe segment shall be 6” long and located at the lowest portion of the instrument tubing. Install horizontal segments of the instrument tubing at a 10% slope down towards the drip leg.

7. Instrument Capillary Tubing:
   a. Install instrument capillary tubing such that tubing is not in contact with process piping, ground or equipment.
   b. Coil excess/slack capillary tubing beneath the pressure transmitter and strap onto support channel with clamp. Take care not to coil tubing at less than the manufacturer recommended radius of curvature, and in no case less than a 6” bending radius.
   c. Install capillary tubing with strict accordance to manufacturer requirements. Do not excessively bend or exert pressure onto capillary tubing during installation to cause damage to the tubing/seals.
8. Instrument Tubing Cutting and Fittings (Non-Capillary):
   a. Cut tubing with sharp cutting tool. Do not flatten tubing or in any way distort the manufacturer original tube diameter dimensions.
   b. File edges of tubing after cutting and remove any filings/shavings prior to making connections.
   c. Provide elbow fittings, tee fittings, reducer fittings, and valves at tube connections. Bending tubing in lieu of elbow fittings is not acceptable.
   d. Clean inside of tubes prior to operation. Clean by blowing out to ensure there is no debris in tubes.

I. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents. Instruments may be shown on the PLANS, in the Specifications or both.

3.03 OPERATION AND MAINTENANCE TRAINING

A. Start-up Training: Provide required instruction to the OWNER's personnel during start-up period.

B. Special Training School: Provide services of a factory-trained instructor or instructors for each of the specified and installed Field Instrumentation and Sensing Devices for a total period of not less than Five (5) eight hour working days for the purpose of instructing the OWNER’s personnel in the correct operating and maintenance procedures for all the Field Instrumentation and Sensing Devices specified under this Section of the Specifications and installed in this project. This is in addition to the training requirements defined in other Sections of Division 17 of the Specifications. The date of this school shall be scheduled with the OWNER, but will be after the entire instrument and control system is in operation and respective Operation and Maintenance Manuals have been submitted and revised per

ENGINEER comments. Also, refer to the additional training requirements defined in other Sections of Division 17 of the Specifications.

1. Provide one (1) month prior notice to schedule class events with OWNER.
2. Submit detailed listing of class curriculum including, as a minimum, with the following at least four (4) months prior to class:
   a. Specific topics for each instrument, including but not limited to, general trouble-shooting, calibration, wiring, and general set-up/configuration.
   b. Anticipated duration of class for each instrument type.
   c. Names of instructor(s) for each specific instrument.
   d. Refer to instrument by Instrument Type Code as listed in this specification section where applicable.

3.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

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SECTION 17404

PRESSURE/VACUUM MEASUREMENT: GAUGES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure/vacuum gauges.

B. Provide all instruments specified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. American Society of Mechanical Engineers (ASME):
   1. B40.100 - Pressure Gauges and Gauge Attachments.

1.03 DEFINITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01300 – Submittals and 17100 - Process Instrumentation and Control Systems (PICS).

B. Additional requirements:
   1. Product data:
      a. Accessories such as diaphragm seals, valve manifold, snubbers, and pulsation dampeners.

1.05 QUALITY ASSURANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.08 WARRANTY

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.09 MAINTENANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
    1. Ashcroft:
        a. Maximum pressure less than 10 pounds per square inch: Model 1188.
            1) If a stainless steel dial casing is required:
                a) Model 1009.
        b. Maximum pressure greater than or equal to 10 pounds per square inch: Model 1279.
            1) If a stainless steel dial casing is required:
                a) Model 1009.
        c. Removable Gauges:
            1) Model 1082.
    2. Wika.
    3. Ametek U.S. Gauge.

2.02 MANUFACTURED UNITS

A. General:
    1. Pressure gauge assembly shall include pressure sensing element, gauge case, and dial mechanism.

B. Performance requirements:
    1. Pressure range:
        a. As specified in the Contract Documents.

2. Accuracy:
    a. Grade 2A, as defined by ASME B40.100.
    b. Within 1.0 percent of span after friction errors are eliminated by tapping or vibration.
    c. Maximum allowable friction inaccuracy: Within 1.0 percent of span.
3. Element:
    a. Where the maximum pressure is less than 10 pounds per square inch, provide socket and bellows; for all other pressure ranges, employ a Bourdon® tube.
    b. Socket tips for bellows and Bourdon® tube:
        1) Materials: Type 316 stainless steel.
    c. Overpressure: Minimum 130 percent of maximum range pressure without damage to gauge or sensing element.
    d. Wetted materials: Type 316 stainless steel.
4. Dial gauge:
    a. Dial size: 4-1/2 inches.
    b. Dial case material:
        1) Maximum pressure less than 10 pounds per square inch:
            a) Phenolic.
        2) Maximum pressure greater than or equal to 10 pounds per square inch:
            a) Stainless steel.
    c. Provide safety gauge with safety blow out through the back or top of the unit.
    d. Dial face: Gasketed shatterproof glass or polycarbonate.
    e. Provide gauge locks on all pressure gauges directly connected to diaphragm seals.
    f. Provide gauge locks where possible.
    g. Connection and mounting:
        1) Direct mounted and suitable for outdoor installation.
        2) 1/2-inch NPT.
        3) Connection material: Stainless steel.
    h. Pointer: Externally adjustable.

2.03 ACCESSORIES

A. Pulsation dampeners and snubbers:
    1. Provide pulsation dampener or snubber with each pressure gauge installed on discharge of positive displacement type pump.
    2. Provide piston-type snubber if pressure spikes will exceed 130 percent of gauge maximum range.
    3. Materials: Type 316 stainless steel.
    4. Mount pulsation dampener or snubber integrally to the pressure gauge.
    5. Connection: 1/2-inch NPT.

B. Provide diaphragm seals as specified in the Contract Documents and in Section 17100 - Process Instrumentation and Control Systems (PICS):
    1. Diaphragm seal and pressure gauge shall be assembled by manufacturer and shipped as an assembly.

C. Provide means for gauge isolation as specified in Section 17380 – Field Instrumentation and Sensing Devices:
   1. Mount valve manifold integrally to the gauge.
   2. Valve manifold and pressure gauge shall be assembled by manufacturer and shipped as an assembly.

D. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Factory calibrate each pressure gauge at a facility that is traceable to the NIST.

C. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

3.05 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer’s instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

A. As specified in Section 01700 – Contract Closeout.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.08 PROTECTION

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

END OF SECTION

A/E:	**Carollo Engineers, Inc.**			**PRESSURE GAUGES**					**Spec. No.**		**Rev.**
Contractor:				**No**	**By**	**Date**	**Revision**		17404		
Project:	Wild Horse WWTP Expansion								**Contract**		**Date**
Customer:	City of Austin										
Plant:	Wild Horse WWTP								**Req.**		**P.O.**
Location:											
BOM No.:									**By**	**Chk**	**App**
File:											

1	**Type**	Direct Rdg.: √		Receiver:		Other:
2	**Mounting**	Surface: Local:				Flush:
3	**Dial**	Diameter: 4.5”			Color:	
4	**Case**	**Cast Iron:**	**Aluminum:**	**Phenolic: √**	**Polished SS**	**Other:**
5	**Ring**	Screwed:	Hinged:	Slip:	Std:	Other:
6	**Blowout Protection**	None:	Disc:	Front:	Other:	Mfr. Std.
7	**Lens**	Glass: √			Plastic:	
8	**Options**	Siphon: N/A			Material:	
9	**Other**	Snubber:				
10	**Other**	Pressure Limit Valve: N/A				
11	**Other**	Movement Damping: N/A				
12	**Nominal Accuracy Required**					
13	**Pressure Element**	Bourdon®: √		Bellows:		Other:
14	**Element Material**	Bronze:	Steel:	Type SS: 316 √		Other:
15	**Socket Material**	Bronze:	Steel:	SS: 316		Other:
16	**Connection**	¼ in.:	½ in.: √	Bottom:		Other:
17	**Movement**	Dampened:	Standard: √	Other:		
18	**Diaphragm Seal**	Mfr.:		Wetted Part Mat’l:		Type:
19	**Other**	Other Mat’l:		Fill Fluid:		Model:
20	**Manufacturer**					
21	**Model No.**					

Rev	**Tag Number**	**Range**	**P&ID**	**Service**	**Notes**
	See Instrumentation List provided in Drawings.				

Notes:
Refer to Section 17380 – Field Instrumentation and Sensing Devices for additional instrument valve requirements.

SECTION 17502

ANALYZERS: ORP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. ORP instruments.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. CSA International (CSA).

1.03 DEFINITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01300 – Submittals and 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17100 - Process Instrumentation and Control Systems (PICS).
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Hach:
      a. Sensor Model DRD1
      b. Transmitter Model SC200

B. All instruments of similar nature must be furnished by the same manufacturer.

2.02 MANUFACTURED UNITS

A. ORP analyzer:
   1. General:
      a. The oxidizing reducing potential (ORP) is a unit of measurement for the state of equilibrium between oxidizing and reducing components of a media. A platinum or gold electrode shall be used with integrated noble metal reference system. The measuring electrode shall generate a voltage output relative to the oxidizing or reducing reactions.
   2. Performance requirements:
      a. Accuracy: Within 1.0 millivolt.

b. Stability: Within 1.0 millivolt per month.
c. Repeatability: Within 1.0 millivolt.

3. Element:
   a. Sensor material:
      1) Platinum ring ORP electrode.
      2) Molded reinforced polypropylene body threaded for submersion.
      3) Steady reference signal from the reference electrode junction by resisting plugging in dirty applications.
      4) Integral temperature sensor.
   b. ORP measuring range: -1,500 to 1,500 millivolts.
   c. Temperature measuring range: 0 to 100 degrees Celsius.
   d. Operating temperature range: 0 to 100 degrees Celsius.
   e. Operating pressure range: 0 to 87 pounds per square inch.
   f. Process connection:
      1) Immersion.
4. Transmitter:
   a. Power supply:
      1) 120 VAC.
      2) Powered via network.
      3) Power consumption: 10 volt-amperes maximum.
   b. Outputs:
      1) Isolated 4 to 20 milliamperes DC.
      2) Relay outputs:
         a) 3 Form C contact.
         b) Rated 3 amps at 250 VAC.
         c) Programmable.
      3) As indicated in the instrument datasheets.
   c. Display:
      1) Backlit LCD digital display.
   d. Measurement ranges: -1,400 to 1,400 millivolts.
   e. Temperature: 0 to 50 degrees Celsius.
   f. Displayed resolution: Within 1.0 millivolts.
   g. Ambient conditions:
      1) Operable from 0 to 50 degrees Celsius.
      2) Relative humidity 0 to 95 percent non-condensing.
   h. Mechanical:
      1) Enclosure rating: NEMA Type 4X (IP65).
      2) Mounting:
         a) Panel mount suitable for easy mounting in enclosures that include gasket to maintain weather rating of the panel.
         b) Surface mount enclosures, including self-tapping screws.
         c) Pipe mounting; accessories included for mounting enclosures to a 2-inch pipe.
      3) Provide all mounting hardware for proper installation and servicing of the sensor assembly.
   i. Conduit connection:
      1) 1/2-inch NPT.
   j. Electrical certification: NRTL certified to UL and CSA standards, and CE approved.

5. Components:
    a. Sensor cable:
        1) Provided watertight sensor-to-cable connector that prevents cable twisting and eliminates rewiring when replacing the sensor.
        2) Cable length: As required to connect sensor to transmitter plus 10 percent.

2.03 ACCESSORIES

A. Sensor:
    1. Cleaning:
        a. Jet spray cleaner:
            1) 1/4-inch compression fitting for process stream.
            2) Manual ball valve shut off.
    2. Low flow cell:
        a. 1/4-inch NPT inlet and outlet tubing for connection to the process stream.
        b. Flow Rate: 2 to 5 gallons per hour.
        c. Pressure Range: 0 to 65 pounds per square inch gauge.

B. Transmitter:
    1. Mounting kit.

C. Preamplifier: Use manufacturer recommended:
    1. Preamplifier required on coaxial cable runs longer than 15 feet.

D. Provide sunshades for outdoor applications.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
    1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
    1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.05 ADJUSTING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.06 CLEANING

A. As specified in Section 01700 – Contract Closeout.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.08 PROTECTION

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	Carollo Engineers, Inc.	ORP ANALYZERS					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17502	
Project:	Wild Horse WWTP Expansion					Contract	Date
Customer:	City of Austin						
Plant:	Wild Horse WWTP					Req.	P.O.
Location:							
BOM No.:						By / Chk / App	
File:							

G	1	Tag No.	Element	Transmitter	AB-AIT-4511, AB-AIT-4521, AB-AIT-4531, AB-AIT-4541	
E	2	Service			Aeration Basin No. 1, 2, 3, 4, Zone 4 ORP Analyzer	
N	3	P&ID			30N01	
	4	Type				
	5	Body Style				
	6	Enclosure				
E	7	Electrodes				
L	8	Ambient Conditions				
E	9	Connection				
M	10	Sample Flow Required				
E	11	ORP Measuring Range				
N	12	Temperature Measuring Range				
T	13	Manufacturer				
	14	Model No.				
	15	Length				
	16	Other			Built in Temperature Sensor	
C	17	Style			N/A	
A	18	Length				
B	19	Model No.				
L	20	Pre-Amplifier				
E	21	Other				
	22	Type			Control Unit and Display	
T	23	Enclosure				
R	24	Mounting				
A	25					
N	26	Power Requirements			115 VAC, 60 Hz	
S	27	Resolution				
M	28	Accuracy				
I	29	Calibrated Range				
T	30					
T	31	Outputs			4-20 mA	
E	32	Contacts				
R	33	Manufacturer				
	34	Model No.				
	35	Display				
	36	Other				
	37	Other				
	38	Other				
O	38	Cleaning				
P	39	Low Flow Cell				
T	38	Process Assembly				
S	38	Other				
	39					

Notes:

SECTION 17506

ANALYZERS: DISSOLVED OXYGEN (DO)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Dissolved oxygen (DO) analyzer.

B. Provide all instruments identified in the Contract Drawings.

1.02 REFERENCES

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.03 DEFINITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. NEMA:
   1. Type 6P enclosure in accordance with NEMA 250.

C. Specific definitions:
   1. DO - Dissolved oxygen.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01300 - Submittals and 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.08 WARRANTY

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Optical:
      a. Hach LDO probe with Hach sc200 or sc4500^{AD5} controller.

2.02 MANUFACTURED UNITS

A. Optical Dissolved oxygen analyzer:
   1. General:
      a. Dissolved oxygen analyzer for continuous monitoring of dissolved oxygen in liquid.
   2. Performance requirements:
      a. Measuring range: 0 to 20 parts per million (ppm).
      b. Sensor accuracy:
         1) Within 0.2 ppm for values above 5 ppm.
         2) Within 0.1 ppm for values below 5 ppm.
      c. Repeatability: Within 0.1 ppm.
      d. Response time:
         1) 90 percent value: Less than 40 seconds.
         2) 95 percent value: Less than 60 seconds.

3. Element:
    a. Optical type that measures the fluorescence or luminescence of a ruthenium or platinum coated sensor.
    b. Using no membrane, electrodes, or electrolyte.
    c. Drift: less than 1 percent per year.
    d. Automatic self-diagnostics.
    e. Integral temperature sensor.
    f. Maximum pressure: 50 pounds per square inch.
    g. Power supply: From transmitter through the sensor cable.
    h. Enclosure: NEMA Type 6P.
4. Transmitter:
    a. Power supply:
        1) 120 VAC.
        2) Power consumption: 75 VA maximum.
    b. Outputs:
        1) Isolated 4 to 20 milliamperes DC with HART communication protocol.
        2) Relay outputs:
            a) 3 Form C contacts.
            b) Rated 5 amps at 120 VAC.
            c) Programmable.
    c. Microprocessor based with features resident in non-volatile memory.
    d. Display dissolved oxygen content with 0.01 ppm resolution over a range of 0.00 to 9.99 ppm and 0.1 ppm resolution over a range of 10.0 to 20.0 ppm.
    e. Display temperature with 0.2 degree Celsius accuracy.
    f. Enclosure rating: NEMA Type 4X.
    g. Automatic temperature compensation.
5. Components:
    a. Manufacturer’s cable for sensor to transmitter connection.

2.03 ACCESSORIES

A. Calibration equipment:
    1. Provide components recommended by the manufacturer to verify calibration.

B. Provide sunshade for outdoor installations.

C. Provide a pole mount kit for mounting the sensor.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer’s standard at a facility that is traceable to the NIST.
    1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.05 ADJUSTING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.06 CLEANING

A. As specified in Section 01700 – Contract Closeout.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.08 PROTECTION

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	Carollo Engineers, Inc.	ANALYZERS - DISSOLVED OXYGEN (DO)				Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17506	
Project:	Wild Horse WWTP Expansion					Contract	Date
Customer:	City of Austin						
Plant:	Wild Horse WWTP					Req.	P.O.
Location:							
BOM No.:						By	Chk App
File:							

G	1	Tag No.	AB-AE/AIT-4512, AB-AE/AIT-4513, AB-AE/AIT-4522, AB-AE/AIT-4523, AB-AE/AIT-4532, AB-AE/AIT-4533, AB-AE/AIT-45142, AB-AE/AIT-4543	DIG-AE/AIT-1223
E	2	Service	Aeration Basin No. 1, 2, 3, 4, Zones 5 and 6 Dissolved Oxygen Analyzer	Sludge Holding Tank No. 2 Dissolved Oxygen Analyzer
N	3	P&ID	30N02	71N01
S	4	Type	Luminescent, Immersion type	Luminescent, Immersion type
E	5	Operating Temperature Range	32 to 122 degrees Fahrenheit	32 to 122 degrees Fahrenheit
N	6	Resolution	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation
S	7	Sensitivity	±0.5% of span	±0.5% of span
O	8	Repeatability	±0.1 ppm	±0.1 ppm
R	9	Accuracy	± 0.1 ppm Below 5 ppm; ± 0.2 ppm Above 5 ppm	± 0.1 ppm Below 5 ppm; ± 0.2 ppm Above 5 ppm
	10	Manufacturer		
	11	Model No.		
C	12	Style	Mfr Std.	Mfr Std.
A	13	Length		
B	14	Model No.		
L	15	Other		
E	16	Other		
	17	Type	Microprocessor-based	Microprocessor-based
T	18	Enclosure	NEMA 4X	NEMA 4X
R	19	Mounting	Remote	Remote
A	20	Range		
N	21	Repeatability	±0.05% of range	±0.05% of range
S	22	Power Requirements		
M	23	Display	Graphic dot matrix LCD with LED backlighting	Graphic dot matrix LCD with LED backlighting
I	24	Resolution	240 x 160 pixels	240 x 160 pixels
T	25	Number of sensor input channels		
T	26	Outputs		
E	27	Manufacturer		
R	28	Model No.		
	29	Ambient Operating Temperature	-4 to 140 degrees Fahrenheit	-4 to 140 degrees Fahrenheit
	30	Relays	4 SPDT type	4 SPDT type
O	31	Mounting Kit		
P	32	Cleaning		
T	33	Power cord		

Notes:

A/E:	Carollo Engineers, Inc,	ANALYZERS - DISSOLVED OXYGEN (DO)				Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17506	
Project:	Wild Horse WWTP Expansion					Contract	Date
Customer:	City of Austin						
Plant:	Wild Horse WWTP					Req.	P.O.
Location:							
BOM No.:						By / Chk / App	
File:							

G	1	**Tag No.**	**SHF-AIT-1213**	
E	2	**Service**	Sludge Holding Tank No. 1 Dissolved Oxygen Analyzer	
N	3	**P&ID**	70N01	
S	4	**Type**	Luminescent, Immersion type	
E	5	**Operating Temperature Range**	32 to 122 degrees Fahrenheit	
N	6	**Resolution**	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation	
S	7	**Sensitivity**	±0.5% of span	
O	8	**Repeatability**	±0.1 ppm	
R	9	**Accuracy**	± 0.1 ppm Below 5 ppm; ± 0.2 ppm Above 5 ppm	
	10	**Manufacturer**		
	11	**Model No.**		
C	12	**Style**	Mfr Std.	
A	13	**Length**		
B	14	**Model No.**		
L	15	**Other**		
E	16	**Other**		
	17	**Type**	Microprocessor-based	
T	18	**Enclosure**	NEMA 4X	
R	19	**Mounting**	Remote	
A	20	**Range**		
N	21	**Repeatability**	±0.05% of range	
S	22	**Power Requirements**		
M	23	**Display**	Graphic dot matrix LCD with LED backlighting	
I	24	**Resolution**	240 x 160 pixels	
T	25	**Number of sensor input channels**		
T	26	**Outputs**		
E	27	**Manufacturer**		
R	28	**Model No.**		
	29	**Ambient Operating Temperature**	-4 to 140 degrees Fahrenheit	
	30	**Relays**	4 SPDT type	
O	31	**Mounting Kit**		
P	32	**Cleaning**		
T	33	**Power cord**		

Notes:

AD5 Addendum No. 5

SECTION 17522

ANALYZERS: TOTAL SUSPENDED SOLIDS (TSS)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Total suspended solids analyzers.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.03 DEFINITIONS

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Specific Definitions:
   1. TSS - Total suspended solids.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01300 – Submittals and 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17100 - Process Instrumentation and Control Systems (PICS):
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. HACH, SOLITAX sc sensor with sc200 controller.

2.02 MANUFACTURED UNITS

A. Suspended solids meter:
   1. General:
      a. The sensor will utilize a single beam pulsed near infrared region (NIR) light source pulsed at 880 nm and built-in LED compensation loop to alleviate drifting due to LED degradation.
   2. Performance requirements:
      a. Total suspended solids range: 30 to 20,000 ppm (mg/l).
      b. Accuracy: Within 3.0 percent of operating range.
      c. Resolution: 1 ppm.
      d. Repeatability: Within 1 percent.
   3. Element:
      a. Constructed of Type 316 stainless steel.
      b. Sealed with EDM/Viton™ seals.

c. Immersion type.
d. Ability to be cleaned by either air or water.
e. The sensor will have a NEMA Type 4 rated enclosure.
f. The sensor will have an operating temperature range of 0 to 60 degrees Celsius (32 to 140 degrees Fahrenheit).
g. Digital communication between sensor and transmitter through M12 cable.

4. Transmitter:
   a. Microprocessor-based signal converter/transmitter capable of supporting 2 independent sensors but upgradable to 2 sensors with expansion board.
   b. Provides plug and play for sensor configurations.
   c. Upgradeable control box design so program can be upgraded to current design at start-up by factory service tech.
   d. Mounted backlit digital display for percent TSS.
   e. Sensors displayed on screen at startup.
   f. Self-diagnostics and automatic data checking.
   g. Ambient operating temperature limits of -20 to 50 degrees Celsius (-4 to 122 degrees Fahrenheit.)
   h. Power supply:
      1) 120 VAC.
      2) Power consumption: 130 VA maximum.
   i. Outputs:
      2) Isolated 4-20 mA DC with HART communication protocol.
      3) Relay outputs:
         a) 2 Form C contacts.
         b) Rated 5 amps at 120 VAC.
         c) Programmable:
            (1) Relays operate flushing solenoid valve operation. Output signal held constant by transmitter during flushing cycle.

5. Components:
   a. Manufacturer cable will be 33 feet and Hytrel shielded.
   b. A 10 meter (33 foot) flushing hosed will be supplied with sensor.

B. Instruments located within hazardous classified areas shall be explosion proof:
   1. Class I, Division 2, Groups A, B, C and D.

2.03 ACCESSORIES

A. Components:
   1. Supply transmitter 1/8-inch aluminum mounting plate as required or as indicated on the Drawings with Type 304 stainless steel 1-1/2-inch pipe U-bolts for mounting to handrails.
   2. Supply opaque sunscreens with stainless steel hinges for all outdoor transmitters.
   3. Mounting bracket for sensor to be Type 316 stainless steel coiled spring design with PVC adaptor or bracket to rod.
   4. Sensor to be attached with PVC adaptor to field adjustable telescoping rod from 5 feet to 14 feet in length. Rod to be fiberglass with UV inhibitor.
   5. Flushing solenoids to be factory mounted to mounting plate and prewired to control box.

B. Provide sunshades for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

B. Install total suspended solids meters in the proper orientation as indicated by the manufacturer, so that meters will be self-draining.

C. Install sensor so it will be submerged at least 12 inches during minimum flow conditions.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

B. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.05 ADJUSTING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.06 CLEANING

A. As specified in Section 01700 – Contract Closeout.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17380 – Field Instrumentation and Sensing Devices.

3.08 PROTECTION

A. As specified in Section 17100 - Process Instrumentation and Control Systems (PICS).

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

END OF SECTION

A/E:	**Carollo Engineers, Inc.**		**ANALYZER - TOTAL SUSPENDED SOLIDS (TSS)**				**Spec. No.**		**Rev.**
Contractor:			**No**	**By**	**Date**	**Revision**	17522		
Project:	Wild Horse WWTP Expansion						**Contract**		**Date**
Customer:	City of Austin								
Plant:	Wild Horse WWTP						**Req.**		**P.O.**
Location:									
BOM No.:							**By**	**Chk**	**App**
File:									

G	**1**	**Tag No.**	**AB-AIT-4514, AB-AIT-4524, AB-AIT-4535, AB-AIT-4544**	**DIG-AIT-1224**
E	**2**	**Service**	Aeration Basin 1, 2, 3, 4 TSS Analyzer	Sludge Holding Tank No. 2 TSS Analyzer
N	**3**	**P&ID**	30N02	71N01
S	**4**	**Type**		
E	**5**	**Operating Temperature Range**		
N	**6**	**Resolution**		
S	**7**	**Sensitivity**		
O	**8**	**Repeatability**		
R	**9**	**Accuracy**		
	10	**Manufacturer**	As specified	As specified
	11	**Model No.**	As specified	As specified
C	**12**	**Style**	Mfr Std.	
A	**13**	**Length**		
B	**14**	**Model No.**		
L	**15**	**Other**		
E	**16**	**Other**		
	17	**Type**	Microprocessor-based	
T	**18**	**Enclosure**		
R	**19**	**Mounting**		
A	**20**	**Range**		
N	**21**	**Repeatability**		
S	**22**	**Power Requirements**	120 VAC	
M	**23**	**Display**		
I	**24**	**Resolution**		
T	**25**	**Number of sensor input channels**		
T	**26**	**Outputs**		
E	**27**	**Manufacturer**		
R	**28**	**Model No.**		
	29	**Ambient Operating Temperature**		
	30	**Relays**		
O	**31**	**Mounting Kit**		
P	**32**	**Cleaning**		
T	**33**	**Power cord**		
Notes:				

SECTION 17600

DISTRIBUTED CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment, and incidentals required, and shall install complete, ready for operation, and test the distributed control system, hereinafter termed the System as shown on the PLANS and as specified.

B. The Instrument and Control System Contractor (ICS) shall provide equipment, materials, software, calibrations, training, startup assistance and system check-out, and other services that are required to successfully interface and interconnect the System and associated equipment that are specified or designated in PLANS or provisions of these specifications for the purpose of providing a fully integrated and functional control system as specified.

C. The ICS shall be responsible for furnishing and installing the Communication System for the Distributed Control System “DCS” shown on the PLANS (installation and testing of the fiber optic cable, Media Converters and validation of communication system), and as specified hereinafter.

D. The ICS shall be responsible for all modifications to the Owner’s existing distributed control system as also shown on the PLANS.

1.02 DISTRIBUTED CONTROL SYSTEM DESCRIPTION

A. General:
   1. The Distributed Control System (DCS) as shown on the PLANS and specified herein, includes, but is not limited to, the following:
      a. Programmable Logic Controllers Subsystem (PLCs),
      b. Communication System Application and System Software,
      c. PLC networking/data communications over existing and proposed Ethernet TCP/IP network as well as Modbus Plus network.
      d. Interface with Power Monitoring Units, Protective Relays, and other devices as shown on the PLANS.
      e. Interface with process/mechanical equipment having packaged control systems as shown on the PLANS.

1.03 RELATED SPECIFICATIONS

A. Refer to Section 17100.

B. This Section covers work related to the Distributed Control System DCS and its Subsystems. Note that this Section does not stand-alone. Many key technical definitions, functional requirements, training, submittals, etc. requirements for the

DCS are given in Section 17100 “Process Instrumentation and Control Systems (PICS)”.

1.04 DISTRIBUTED CONTROL SYSTEM (DCS) SUBMITTALS

A. General: Submit the following in accordance with the Section 01300 of the Specifications.

B. Hardware:
   1. Shop drawings, product data, bill of materials
   2. Control system architecture block diagram,
   3. Wiring diagrams
   4. Spare parts listing.

C. Fiber-Optic Cable Plant Design: Submit fiber-optic cable types, installation procedure, and fiber flux budget/gain margin calculations.

D. Fiber Optic and Ethernet System Copper Cable Testing Submittal: Provide a complete set of cable test results for the testing required under subsection 3.02 “Fiber-Optic System and Ethernet System Copper Cable – Source Quality Control”, this Section of the Specifications. Format and quantity of reports shall be per the requirements of Section 01300 of the Contract Specifications Provide the OWNER with a typewritten results of all tests, including a description of the equipment tested, the date and time of day tested, test values, results. Test reports shall be signed by the ICS representative

E. PLC I/O “Host Pack Template” Spreadsheets:
   1. The Owner has standard Excel spreadsheet templates, termed the “Host Pack Template” of enumerating information about the I/O points for the installation of the system. Upon completion of the system installation and PAT, the Owner shall supply to the ICS the Host Pack Template in Excel format for the contractor to complete.
   2. The Contractor is to complete and submit in Excel format the Owner provided Host Pack Template.

F. Operations and Maintenance O&M Manuals:
   1. Hardware: As minimum, provide the following:
      a. Final approved versions of all shop drawing submittals.
      b. Component Manufacturers’ O&M Manuals including manuals to cover installation, operation, maintenance, troubleshooting, and calibration.
      c. List of spare parts and expendables provided and list of spare parts recommended.

G. Training Submittals: Submit not less than 4 weeks prior to the time that the associated training is to be provided. Submit per Section 17100.

H. Additional submittals as required by Specifications Section 17100, Section 01300 and Section 01730 of the Contract Specifications.

I. Refer to the requirements of Specifications Section 17100.

J. Configuration System Submittal per subsection 2.09, this Section of the Specifications.

1.05 SPARE PARTS

A. Provide the following spare parts at minimum:
   1. Provide the following SPARE equipment, complete with all accessories:
      a. PLC processor units (CPU Modules): Two (2) of each type used
      b. PLC power supply units: Ten Percent (minimum of 2) of the number required for each type of PLC used
      c. PLC RIO Head module: Ten Percent (minimum of 2) of the number required for each type of PLC used
      d. PLC RIO Drop Module: Ten Percent (minimum of 2) of the number required for each type of PLC used
      e. PLC I/O Module (AI, AO, DI, DO): Ten Percent (minimum of 2) of the number of each type used.
      f. PLC rack: One (1) of each type used.
      g. Local Area Network (LAN) system component (converter, modem, transceiver, etc.): Ten percent (minimum of 2) of each type provided
      h. Ethernet NOE module: Ten Percent (minimum of 2) of the number required for each type of PLC used.
      i. PLC rack extender module, terminator, and cabling: Ten Percent (minimum of 2) of the number required for each type of PLC used.
      j. One (1) ethernet switch complete will all modules for each type used
      k. One (1) spare OIU of each type used, complete with all accessories.
      l. One (1) spare media converter, of each type used.
      m. All spare parts shall be of the same manufacturer, model, and software revision as the installed component, and shall be provide complete with all accessories.

PART 2 PRODUCTS

2.01 GENERAL

A. Refer to Section 17100.

B. General Requirements:
   1. Power source parameters:
      a. 120 volts A.C., plus or minus 10 percent, 60 Hertz
      b. Regulators and power supplies required for compliance with the above shall be provided.
   2. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.
   3. All components and interconnecting wiring shall be provided as required to satisfy the functional and operational requirements of this Specification.
   4. All equipment to be installed in a control panel or on a rack, including switches, etc., shall be tagged according to the guidelines outlined in Section 17200 “Instrumentation and Control Cabinets and Associated Equipment”, of these Specifications.

5. Unless otherwise specified, tag each outlet face plate with white Label with black lettering of minimum height ¼" where label is TTP Continuous polyester thermal transfer label as manufactured by Tyco, or approved equal, with ribbon and printer by label manufacturer.
6. Communication Cables: Provide all cables for interconnection between all components of the DCS inside the and/or in duct/conduit banks, as applicable. These cables shall include cables to the various PLCs I/O racks, power supplies, central processing units, patch panels, ethernet switches, computers, etc. All cables shall be tagged per Section 17200 "Instrumentation and Control Cabinets and Associated Equipment".
7. All equipment cabling, including copper Ethernet cable, all patch cords, etc., shall be tagged according to the guidelines and tagging labeling system outlined in Section 17200 "Instrumentation and Control Cabinets and Associated Equipment", of these Specifications. For tagging of cables with manufacturer pre-connected cable ends, e.g. patch cords, power cords, etc., furnish and install SP self-laminating polyester labels (minimum 2" long along length of cable) with thermal transfer printable, low profile translucent polyester film with a permanent acrylic adhesive as manufactured by Tyco, or approved equal, with respective printer and ribbon type by label manufacturer. Tag all S.O. type power cords with the tag of the equipment served.

2.02 PROGRAMMABLE LOGIC CONTROLLERS (PLCS)

A. General:
   1. Provide all hardware and software features required to make the PLCs totally operational.
   2. The PLCs shall include, but not be limited to, the equipment components called for on the PLANS and in these specifications. Capacities and/or quantities shown are minimum. Provide additional capacity or units as necessary to meet the functional requirements.
   3. Availability:
      a. Subsystem Availability Calculation: The Subsystem availability (A) for the PLC's is defined as average of the individual PLC availabilities (Ai) times the nonspecific availability (NA). That is, A = NA*(Al*A2*A3 ... *An)/n, where n is the number of PLC's.
      b. Availability Requirements: The PLC's availability shall be at least 99 percent.
      c. Component and Backup Definitions: For purposes of the availability calculations, each PLC, each PLC power supply, its process I/O, and data highway interface is considered to be an individual component. There are no backup components.
   4. Communications:
      a. Failure of any PLC or DCS component connected to the communications system network shall not affect the ability of the remaining components on the network to communicate with each other.
      b. Data Highway DH Link Requirements:
         1) Fast Ethernet (100BaseFX), as minimum
         2) Minimum operating distance: 10,000 feet
         3) Rate: 10/100 Mbps.

c. The remote I/O shall be single channel, Ethernet, in a ring network topology. All remote I/O cabling and installation shall be in accordance to the Modicon M580 System Planning Guide.
d. Fiber Optic Link Requirements:
1) Minimum gain margin: 4 dB. The Flux Budget/Gain margin is the difference between the system gain of the fiber-optic transmitter/receiver and the calculated loss budget of the fiber-optic link (fiber-optic cable, connectors, patch cords, and splices) when both are expressed in decibels (dB)).
e. All copper Ethernet cables shall have a category 6A RJ-45 connector and category 6A cable. The connector end shall be the Boot type connector and preinstalled by the Ethernet patch cable manufacturer.
f. Modbus and Modbus Plus shall be in accordance to the Square D standard for cable pin out and cable type, as well as the end devices to be interconnected. The cables shall be shielded. Refer to the Square D Modicon Hardware Reference Guide for Modbus serial cable pin out and guidelines. Furnish and install ruggedized taps and terminators were available from the manufacturer.

B. Type 1 Programmable Logic Controllers (PLCs):
1. Each programmable logic controller shall consist of central processor, process controller, power supply, memory, input/output, interconnecting cables, and optional items as specified.
2. Power Supply:
a. Manufacturer: MODICON M580 Automation Series model number BMX CPS 3500, No Equal.
b. Accessories: Provide screw clamp type removable terminal blocks, Modicon M580 model number BMX XTS CPS10 No Equal.
3. Central Processor:
a. Memory: 65535 Kbytes, at minimum
b. Ports: 1 mini B Universal Serial Bus (USB) port, 1 Ethernet service port, and 2 Ethernet Modbus TCP/IP port
c. Accessories: Provide a 4 GB SD Memory Card, as manufactured by the CPU manufacturer.
d. Manufacturer: Schneider Electric MODICON M580 BME P58 4040, No Equal.
4. Discrete Input Module DI:
a. Manufacturer: MODICON M580 Automation Series Model number BMX DAI 1604 No Equal.
5. Discrete Output DO:
a. Manufacturer: MODICON M580 Automation Series model number BMX DRA 0815 No Equal.
6. Analog Input Module AI:
a. Manufacturer: MODICON M580 Automation Series model number BMX AMI 0810 No Equal. With each module, furnish and install cage clamp terminal block Modicon Model BMXFTB2800, No Equal.
7. Analog Output Modules AOs:
a. Manufacturer: MODICON M580 Automation Series model number BMX AMO 0410 No Equal

8. Network Option Ethernet (NOE):
    a. Manufacturer: Modicon M580 Automation Series model number BME NOC 0311 Module, No Equal.
9. PLC Racks
    a. X bus and Ethernet Bus interface. Manufacturer: MODICON M580 Automation Series model number BME XBP 1200 No Equal
10. PLC Rack Extender Module:
    a. Accessories:
        1) Provide X bus extender cord, length as required per PLANS, manufactured by Extender Module manufacturer, model number BMX XBC series No Equal.
        2) Provide line terminator for extender module located at each end of the daisy chain, manufactured by the Extender Module manufacturer, model number TSXTLYEX, No Equal.
    b. Manufacturer: MODICON M580 Automation Series model number BMX XBE 1000 No Equal
11. Remote I/O Drop Module:
    a. Manufacturer: MODICON M580 Automation Series model number BME CRA 31210 No Equal.
12. Accessories:
    a. Unless specified otherwise, provide 20-way screw clamp type removable terminal block with each module, Modicon Model BMXFTB2010, no equal.
    b. Provide a protective cover for each spare (empty) slot, Modicon Model BMX XEM 010, no equal.

C. Type 2 Programmable Logic Controllers (PLCs):
1. Each programmable logic controller shall consist of central processor, process controller, power supply, memory, input/output, interconnecting cables, and optional items as specified
2. Power Supply:
    a. Manufacturer: MODICON M340 Automation Series model number BMX CPS 3500, No Equal
    b. Accessories: Provide screw clamp type removable terminal blocks, Modicon M340 model number BMX XTS CPS10 No Equal.
3. Central Processor:
    a. Memory: 4096 Kbytes, at minimum
    b. Ports: 1 mini B Universal Serial Bus (USB) port, 1 Modbus communication port, and 1 Ethernet Modbus TCP/IP port
    c. Accessories: Provide a 16 MB FLASH Memory Card, as manufactured by the CPU manufacturer.
    d. Manufacturer: Schneider Electric MODICON M340 BMX P34 2020, No Equal
4. Discrete Input Module DI:
    a. Manufacturer: MODICON M340 Automation Series Model number BMX DAI 1604 No Equal
5. Discrete Output Module DO:
    a. Manufacturer: MODICON M340 Automation Series model number BMX DRA 0815 No Equal
6. Analog Input Module AI:
    a. Manufacturer: MODICON M340 Automation Series model number BMX AMI 0810 No Equal

7. Analog Output Module AO
    a. Manufacturer: MODICON M340 Automation Series model number BMX AMO 0410 No Equal
8. Network Option Ethernet (NOE)
    a. Manufacturer: Modicon M340 Automation Series model number BMX NOE 0100 Module, No Equal
9. PLC Racks:
    a. Manufacturer: MODICON M340 Automation Series model number BMX XBP 1200 No Equal
10. PLC Rack Extender Module:
    a. Accessories: Provide extender cord, length as required per PLANS, manufactured by Extender Module manufacturer, model number BMX XBC series No Equal.
    b. Manufacturer: MODICON M340 Automation Series model number BMX XBE 1000 No Equal
11. Accessories:
    a. Provide 20-way screw clamp type removable terminal block with each module, Modicon Model BMXFTB2010, no equal.
    b. Provide a protective cover for each spare (empty) slot, Modicon Model BMX XEM 010, no equal.

2.03 TYPE 1 OPERATOR INTERFACE UNIT

A. General: The OIU shall effectively be a Graphical front end to the local PLC network and have complete read/write access to all registers of the local PLC network to which the OIU is connected.
    1. Communication:
        a. The OIU shall utilize Ethernet communication protocols to communicate to other peripheral devices, including PLC's, as shown in the contract drawings.
        b. The ICS shall provide the necessary cabling for communicating with the OIU for programming and configuration purposes with a personal computer. The program cabling shall be USB and minimum of 12 feet in length.
        c. The ICS shall install the necessary cabling, connectors, and termination for communication between the OIU Ethernet interface and the Ethernet network.
    2. Software:
        a. Operating System: Magelis Operating system, with latest service Pack, preinstalled by the OIU manufacturer.
        b. Software: Vijeo Designer run time software, preinstalled by the OIU manufacturer.
        c. All additional necessary software, software drivers, etc. complete will all licenses, as necessary for the proper operation of the OIU.
    3. Mounting:
        a. Mount in control panel door as shown on the Drawings. All communication ports shall be accessible with OIU installed in the control panel.
        b. Provide mounting hardware as required and install OIU according to manufacturer's instructions and requirements. Provide trim accessories to seal the gap between the OIU and control panel door.

4. Accessories:
    a. 1 Gigabyte secure digital (SD) card, manufactured by the OIU manufacturer.
    b. All necessary cables, connectors, and terminators. Minimum cable length shall be 12 feet

B. Display Module:
1. Type: Flat Color Active Matrix (TFT) LCD display type, with touch screen capability
2. Size: 15” diagonal
3. Minimum Resolution: 1024 x 768 pixels,
4. Colors: 16,000,000 colors
5. Power Input: 24 volts DC.
6. Communication Ports:
    a. One (1) USB 2.0 Type A port,
    b. One (1) USB 2.0 Mini-B port
7. Physical Environment:
    a. Ambient Air Temperature: +32° to +140° Fahrenheit
    b. Ambient Air Humidity: 10% to 90% Relative Humidity Non-condensing
    c. Free of corrosive gases
8. Cooling Method: Natural air circulation
9. Enclosure: NEMA 4X rated
10. Manufacturer: Schneider Electric Magelis GTU HMIDT732, No Equal.

C. Box Module:
1. Power Input: 24 volts DC.
2. Memory:
    a. System Card: SD Card 1 GB
    b. Internal Memory: 256 MB RAM
    c. Backup Memory: 512 kB NVRAM
    d. Memory Storage Extension: SD Card 4 GB
3. Communication Ports:
    a. Two (2) RJ-45 Ethernet ports,
    b. Two (2) USB 2.0 Type A ports,
    c. One (1) USB 2.0 Mini-B port,
    d. One (1) RJ-45 RS-485 serial port,
    e. One (1) 9 pin RS-232/422/485 serial port,
    f. Two (2) SD card slots [one (1) system and one (1) storage]
4. Communication Protocol: Ethernet, Modbus TCP/IP
5. Output Interface:
    a. One (1) 300 mW speaker output,
    b. One (1) 24 VDC auxiliary alarm output
6. Physical Environment:
    a. Ambient Air Temperature: +32° to +140° Fahrenheit
    b. Ambient Air Humidity: 10% to 90% Relative Humidity Non-condensing
    c. Free of corrosive gases
7. Cooling Method: Natural air circulation
8. Manufacturer: Schneider Electric Magelis GTU HMIG3U, No Equal.

2.04 TYPE 2 OPERATOR INTERFACE UNIT

A. General: The OIU shall effectively be a Graphical front end to the SCADA network and have complete read/write access to all registers of the plant SCADA network to which the computer is connected.

B. Display screen:
   1. Type: Flat Color Active Matrix (TFT) LED display type, with touch screen capability
   2. Size: 21.5" diagonal
   3. Minimum Resolution: 1920 x 1080 pixels
   4. Colors: 32 bit color
   5. Projected capacitive touchscreen
      a. 5-point multi-touch operation (up to 16 touch points)
      b. Can be operated with hands, pens, or gloves
      c. Strengthened 4 mm cover glass
   6. Accessories:
      a. Pop up window for numeric keypad and alphanumeric keypad displays
      b. Touch sensitive protective film harsh environment coating

C. Hardware:
   1. Communication Ports:
      a. Two (2) RS-232 ports
      b. Four (4) USB 3.0 ports
      c. Three (3) 10/100/1000 Base Tx Ethernet port. Ports may be obtained by use of Ethernet module installed in PCI slot
   2. Enclosure: Stainless steel, NEMA 4 rated
   3. Power Input: 24 volts DC
   4. Hard Drive: Minimum of 320 GB solid state disk
   5. Processor: Intel i7 processor with minimum 3 GHz clock speed
   6. Memory: 8 GB RAM, at minimum.

D. Communication:
   1. The OIU shall utilize Ethernet communication protocols to communicate to other peripheral devices, including PLC's, as shown in the contract drawings.
   2. The ICS shall install the necessary cabling, connectors, and termination for communication between the OIU Ethernet interface and the Ethernet network.

E. Software:
   1. Operating System: Windows 10 Professional, 64 bit Operating system, with latest service Pack, preinstalled by the OIU manufacturer.
   2. Latest version of GE Proficy IFix Client runtime license, and software media. Furnish for installation by the Owner. The licensing is to be the GE Advantage Licensing type to be furnished by Contractor and installed by Owner.
   3. All additional necessary software, software drivers, etc. complete with all licenses, as necessary for the proper operation of the OIU.

F. Keyboard:
   1. Sealed to Nema 4X standards, heavy duty industrial type keyboard suitable for harsh environment.

2. 113-key functionality (includes a separate numeric keypad and 20 function keys) Integrated Button Pointer.
3. Key Material - Industrial silicone rubber
4. Key Travel: 0.098", 0.45 lb. nominal actuation force, 10 million cycle life
5. Three year warranty
6. Full-Travel Wall Mount Keyboard with Button Pointer Model KB-R2-WMT-BLK-4-USB as manufactured by Hope Industrial.
7. Mount Keyboard on front of panel door below OIU using keyboard vendor provided mounting hardware and template. Mount keyboard such that the typing surface of the keyboard is 38” above finished floor (floor on which user is standing to face OIU), inclusive of housekeeping concrete pad height. Mount keyboard such that it is horizontally centered on the door.

G. Mounting:
1. VESA mount OIU on face of control panel at door shown on the Drawings. All communication ports shall be accessible with OIU installed on the control panel.
2. Provide mounting brackets and hardware as required and install OIU and all accessories according to manufacturer’s instructions and requirements.

H. Accessories:
1. All necessary cables, connectors, and terminators. Minimum cable length shall be 12 feet
2. VESA mount Fixed Low-Profile Flat-Panel Mount bracket. Coordinate bracket with OIU mounting requirements. Bracket shall be model PRF as manufactured by Premier Mount, or approved equal.
3. Keyboard Bracket.
4. Panel mountable, gasketed, Nema 4X rated split cable gland kit for all cables connecting to OIU through control panel door. Split cable gland kit shall be as manufactured by Icotek Kel-ER, or approved equal.
5. Nema 4X gasketed cable grommets for final cable connection to OIU per the OIU manufacturer’s recommendations.

I. Manufacturer: Noax Technologies Steel Series S21WP complete with specified accessories, No Equal.

2.05 ETHERNET CONVERTER

A. Ethernet Media Converter: The Ethernet Media Converter shall be used for the conversion of Ethernet protocol between fiber optic and copper media. The Media Converter shall be as follows:
1. 24VDC power input rating.
2. DIN Rail mountable
3. Ports:
   a. one (1) 100Base-FX Single-Mode fiber port, with SC-Duplex connector
   b. one (1) RJ45 10/100Base-TX copper port
4. Class 1 Div 2 Rating
5. Operating temperature range: -40°C to 75°C
6. The Media Converter shall have DIP switches for features as follows and shall be set as follows:
   a. Port Alarms Disabled

b. Link pass through Enabled
c. Fiber Full Duplex Enabled
d. Converter Mode Enabled

7. Lifetime warranty
8. The Media Converter shall be the industrially hardened type as manufactured by Transition Networks.

B. Modbus TCP/IP to RS-485 Converter: Where shown on the PLANS, furnish and install Modbus TCP/IP to RS-485 converter. The converter shall convert between Modbus TCP/IP Ethernet protocol and Modbus RTU serial RS-485 protocol. The converter shall be as follows:
1. 24VDC power input rating.
2. DIN Rail mountable
3. Ports:
a. Two (2) RJ45 10/100Base-TX copper ports.
b. One RS-232 or RS-485 (2-wire or 4-wire), depending on settings
4. Operating temperature range: -25°C to 70°C
5. The Modbus TCP/IP to RS-485 Converter shall be the Powerlogic Link150 EGX150 as manufactured by Schneider Electric.

2.06 ETHERNET SWITCHES

A. General:
1. Provide and install Ethernet switches for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components herein shall be provided as minimum for bidding purposes. It is anticipated that Ethernet Switch technology will advance over time and the latest model of Ethernet switch having the features specified hereinafter as a minimum shall be furnished and installed.
2. All switches shall be provided with the latest firmware from the manufacturer, where applicable. Switches to be stacked must be supplied with the same feature set, IP LAN, IOS, etc.
3. All switches shall be supplied with the manufacturer's support contract for the duration of two years starting from final completion of the project. At minimum switches manufactured by Cisco shall have the Cisco SMART NET for a minimum of two (2) years starting from final completion of the project and registered in the name of the Owner.
4. SFP Module: Each SFP module shall be the 1000BASE-LX/LH Long Haul module with duplex LC single mode connector. All SFP modules shall be as manufactured by Cisco. Where Drawings show an SFP module in the switch, furnish and install an SFP module onto the switch. Furnish and install SFP modules of minimum quantity to match that shown on the drawings for each switch.
5. Furnish and install vertical wireway along each side of each switch as well as horizontal wireway above and below each switch.
6. Should the specified switch be designated as "End of Life" and/or discontinued by its manufacturer, contractor shall furnish and install an alternate switch, whose specifications meet or exceed the specified switch, by the same manufacturer and that is not designated as "End of Life" and/or discontinued by the switch manufacturer.
7. Ethernet Switch Inspection Report:

a. For each Ethernet switch furnished, including spare, perform testing of the Ethernet switch as follows:
    1) Power up Ethernet switch and assure that no fault or error is indicated implying failure or malfunction of the switch.
    2) For each port and SFP module with specified SFP module inserted, perform the following tests
        a) Link light: assure link light correctly illuminate and extinguishes when an Ethernet copper or fiber link is established and disconnected, respectively.
        b) Data activity light: assure data activity light illuminates during data transport of the Ethernet switch port.
        c) Ping test: install Ethernet equipment to a specific port on the switch, herein after referred to as the “test” port, and successively install another IP equipment on each of the other ports and SFP modules on the switch. Perform an IP ping between the test port and each other port and SFP module on the switch to assure successful ping between the IP devices.
    3) Document the result of the tests in the Ethernet Switch Inspection Report. For each Ethernet switch, include the switch tag name (or spare), manufacturer, model number, and serial number. For each SFP Module, include the SFP Module manufacturer, model number, and serial number.

B. Type 1 Ethernet Switches:
    1. Power Input: 120 volts A.C., 60 Hz.
    2. Mounting: 19” rack mount
    3. Port Quantity and Type: minimum 24 10/100/1000Base TX ports, 4 of which are dual purpose ports which the user may elect to use as a 10/100/10000Base TX port or as a socket for an SFP module.
    4. Accessories:
        a. LAN Base image
        b. For each Ethernet switch, furnish and install 120VAC Ethernet Switch power supply, model PWR-RGD-AC-DC-250 by Cisco. Where two (2) 120VAC power circuits are shown supplied to the Ethernet switch on the PLANS, furnish and install two (2) such power supply modules.
    5. Manufacturer: Cisco Industrial Ethernet Switch IE-4010-4S24P.
    6. Power Input: 120 volts A.C., 60 Hz
    7. Module: Provide minimum one (1) 1000BaseLX/LH SFP modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module with duplex LC single-mode connector.

C. Type 2 Ethernet Switches:
    1. Power Input: 120 volts A.C., 60 Hz. Unit shall be equipped with its own power supply.
    2. Mounting: 19” rack mount
    3. Port Quantity and Type: minimum 48 10/100/1000Base TX ports, 4 of which are dual purpose ports which the user may elect to use as a 10/100/10000Base TX port or as a socket for an SFP or SFP+ module.
    4. Module: Provide minimum 1 SFP 1000BaseLX/LH modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module. These SFP modules shall be included as part of the base bid.

5. Furnish and install second, redundant power supply for the Ethernet switch.
6. With exception of the SFP modules, this device is to be purchased under the SCADA allowance. Refer to SCADA Allowance Equipment in this specification section.

D. Type 3 Ethernet Switches:
1. Power Input: 120 volts A.C., 60 Hz. Unit shall be equipped with its own power supply.
2. Mounting: 19" rack mount
3. Port Quantity and Type: 12 sockets for SFP modules, and two Stackwise ports.
4. The switch shall have layer 3 routing capability.
5. Module: Provide minimum 12 SFP 1000BaseLX/LH modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module. These SFP modules shall be included as part of the base bid.
6. For each switch, furnish Stackwise cabling, of sufficient length, to interconnect switches in nearby panel sections/racking arrangement. Refer to PLANS.
7. With exception of the SFP modules, this device is to be purchased under the SCADA allowance. Refer to SCADA Allowance Equipment in this specification section.

E. Type 4 Ethernet Switches:
1. Power Input: 120 volts A.C., 60 Hz
2. Mounting: Where shown to be 19-inch rack mounted, furnish and install 19-inch rack mounting kit. Otherwise, furnish and install all accessories for DIN rail mounting. Refer to the PLANS.
3. Port Quantity and Type: 16 10/100/1000 BaseTx Ethernet ports and 4 dual purpose uplinks. Each dual-purpose uplink shall consist of one (1) 10/100/1000BaseTx Gigabit Ethernet port and one SFP based Gigabit Ethernet port, with one port active at a time.
4. Module: Provide minimum one (1) 1000BaseLX/LH SFP modules with each switch. All SFP modules shall be the 1000BASE-LX/LH Long Haul module with duplex LC single mode connector.
5. Accessories:
   a. For each Ethernet switch, furnish and install DIN-rail adapter for back plane mounting model by Cisco.
   b. LAN Base image
   c. For each Ethernet switch, furnish and install 120VAC Ethernet Switch power supply, model PWR-IE170W-PC-AC= by Cisco. Where two (2) 120VAC power circuits are shown supplied to the Ethernet switch on the PLANS, furnish and install two (2) such power supply modules.
6. Manufacturer: Cisco Industrial Ethernet Switch IE-4000-16GT4G-E.

F. Type 5 Ethernet Switches:
1. Power Input: 24 volts D.C.
2. Mounting: DIN rail mount
3. Port Quantity and Type: Five (5) 10/100/1000 BaseTx Ethernet ports
4. Switch shall be the unmanaged type and without power over Ethernet
5. Operating Temperature Range: -40 degrees Celsius to 85 degrees Celsius
6. Manufacturer: Red Lion (N-Tron) 1005TX, or approved equal.

G. Accessories:
   1. Furnish and install mounting brackets and hardware as required to install each Ethernet Switch according to manufacturer's instructions and requirements
   2. Furnish and install all necessary cables, connectors, and terminators as required for a complete and functional installation

2.07 FIBER-OPTIC CABLES AND CONNECTORS AND HARDWARE GENERAL SPECIFICATIONS REQUIREMENTS

A. General: Provide and install fiber-optic cables, connectors, panels, cords, and enclosures for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components specified herein shall be provided as minimum for bidding purposes.

B. Each fiber cable, as depicted on the PLANS, represents a minimum of two (2) fiber strands. A loose tube fiber cable, as depicted on the PLANS, represents the quantity of fiber strands equal to the loose tube fiber strand count as specified in this section of the specifications.

C. Fiber-Optic Cables:
   1. General: Provide and install fiber-optic cables, connectors, panels, cords, and enclosures for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components specified herein shall be provided as minimum for bidding purposes.
   2. Multiple types of fiber optic cable are required for this project as hereinafter specified. Unless specifically shown otherwise on the PLANS, all fiber optic cable shall be assumed to be Type 1.
   3. Type 1 Fiber Optic Cable:
      a. Cable shall be Communication System Data Highway “DH” Fiber-Optic Cable. Each link external to/outside the respective Building/Room containing the Main Control Panels MCPs and the PLC Cabinets shall consist of loose tube fiber-optic cables (one cable for primary data highway communications, and another for secondary/backup data communication highway DH).
      b. Cable shall consist of 72 strands of Single-Mode fiber.
   4. Type 2 Fiber Optic Cable:
      a. Cable shall be Communication System Data Highway “DH” Fiber-Optic Cable. Each link external to/outside the respective Building/Room containing the Main Control Panels MCPs and the PLC Cabinets shall consist of loose tube fiber-optic cables (one cable for primary data highway communications, and another for secondary/backup data communication highway DH).
      b. Cable shall consist of 12 strands of Single-Mode fiber.
   5. Type 3 Fiber Optic Cable:
      a. Cable shall be Security System Data Highway cable as well as Telephone System Data Highway cable. Each link external to the respective Building/Room containing the Security System Control Panels and the Telephone System Control Panels shall consist of loose tube fiber-optic cables as shown on the PLANS.
      b. Hybrid Multi Mode and Single Mode fiber type.

c. Cable shall consist of 18 strands of Single Mode fiber and 18 strands of Multi Mode fiber.

6. General Requirements for all types of Fiber Optic Cables:
   a. All fiber optic cable shall be Loose tube fiber cable
   b. Construction: Loose tube construction, allowing for thermal expansions and free movement of the fiber within the protective container.
   c. Protective Coverings: Continuous and be of the same material, free from holes, splices, blisters, and other imperfections.
   d. Flooding Compound: Applied into the interior of the fiber buffer tubes.
   e. Strength members:
      1) Integral part of the cable construction
      2) Sufficient to support the stress of installation and to protect the cable in service.
   f. Outer cable jacket: polyethylene (PE), except for the fiber that is run inside a building.
   g. Additional Requirements:
      1) Lightning resistant.
      2) Fully water blocked.
   h. Manufacturer: ALTOS loose tube type Fiber-Optic cable as manufactured by Corning Cable Systems LLC, or approved equal.
7. Optical fibers:
   a. Coated with a suitable material to preserve the intrinsic strength of the glass.
   b. Protected by a protective tube, a jacketed strength member, and an exterior jacket.
8. Fibers that are multi-mode shall be graded index, solid glass waveguides with the following characteristics:
   a. Nominal core diameter: 62.5 microns.
   b. Outside clad diameter: 125 microns.
   c. Minimum ellipicity: 2.0 percent
   d. Minimum Numerical Aperture (NA): 0.275
   e. Maximum attenuation (850 nm): 2.7 db/Km
   f. Minimum bandwidth (850 nm): 800 MHz/Km
   g. Maximum attenuation (1300 nm): 1.0 db/Km
   h. Minimum bandwidth (1300 nm): 800 MHz/Km
9. Fibers that are single-mode shall be solid glass waveguides with the following characteristics:
   a. Nominal core diameter: 8.3 microns.
   b. Outside clad diameter: 125 microns.
   c. Maximum attenuation (1310 nm): 0.5 db/Km
   d. Maximum attenuation (1550 nm): 0.4 db/Km
10. Glass cladding: Nominally concentric with the fiber core.
11. Each fiber shall be continuous with no factory splices

D. Fiber Optic Cable Terminations:
   1. Furnish and install a spider fan-out kit at each end of the cable with the following features:
      a. Modular 6 fiber inserts
      b. Buffer inserts shall consist of size 1 meter long fan-out buting secured in a composite encasing

c. Fan-out tubing shall consist of Teflon inner tube, an aramid yarn strength member, and an outer protective jacket
d. Kit shall be suitable for use with respective type fiber cable
e. Manufacturer: Corning “Spider Fan out Kit”, or approved equal.

2. Additional Requirements:
a. Provide Furcation Unit and Loose Tube Cable End kits. Furnish and install single mode kits and multi-mode kits corresponding to the type of fiber optic cable terminated.
b. Provide a minimum 20.0-foot coil of spare fiber in each manhole throughout the cable length as well as at each patch panel.
c. Terminate fiber optic cable only at the low voltage control panel and fiber patch panels as shown on the PLANS. Do not splice fiber optic cables elsewhere.
d. Terminate all strands of a loose tube fiber optic cable in one, and only one, spider fan out kit.
e. All fiber optic cables shall be tested for performance and loss after termination and installation to verify that at least a 4dB power safety margin is obtained between all transmitters and receivers. Test data for each fiber and safety margin calculations for each fiber path shall be provided to the OWNER and ENGINEER after installation to verify conformance with this specification.

E. Fiber Optic Connectors:
1. General:
a. Provide same type mating connectors for the fiber-optic device and the fiber cable end.
b. Fiber Strand Connector Type:
1) For all loose tube fiber cable, furnish and install SC single mode splice-on connector at each end of the strand. The connector shall be factory pre-polished connector and shall have a factory terminated pre-cleaved fiber strand pigtail that is suitable for machine aligned fusion splicing. The connector shall have a ceramic ultra polish Zirconia ferrule, color coded buffer, cleave protector, splice protection boot, and dust protection cap. Connectors shall be manufactured by “FIS Cheetah Splice-On Connector”, or approved equal.
2) Coordinate type of connector with the device termination. Where fiber strand terminates directly to a fiber/optic communication device (e.g., security camera device), connector type shall be the type as required to mate with connector(s) on device.
c. Termination Location: All outdoor Fiber Optic Cable shall be connectorized, at each end of the cable, to a patch panel located inside the building or equipment packaged control panel to which the cable is routed.
d. Each loose tube fiber strand ends shall be terminated to a patch panel connector panel.
2. Terminology:
a. An “SC-Duplex” connector is two (2) SC connectors abutted next to each other. Hence, a single “SC-Duplex” connector shall carry two fibers. Similarly, a single “SC-Duplex” adapter shall accept two fibers

b. The Insertion loss is the db loss across two (2) connectors, of the same type, which are mated with each other using a fiber optic adapter of that same type

3. Type:
   a. Use fusion splice-on type connectors, except for those patch cords which are to be preconnectorized by the manufacturer. The connector shall conform to the following:
      1) Single-mode insertion loss (typical/maximum): 0.2db/0.3db. Multi-mode insertion loss (typical/maximum): 0.4db/0.5db.
      2) Cable Retention: 2.5 pounds.
      3) Type: Factory pre-terminated and pre-polished ceramic ultra-polish zirconia ferrule with fiber stub previously specified.

F. Fiber-Optic Patch Panels:
   1. General Requirements For Each Patch Panel:
      a. Each port on a fiber optic patch panel, as depicted on the PLANS, represents an interconnection to a minimum of two (2) fiber strands. Those ports depicted on the PLANS connected to a loose tube fiber cable represents an interconnection to a minimum of the number of fiber strands within the loose tube fiber optic cable, in accordance to the loose tube fiber strand count as specified in this section of the specifications.
      b. All Fiber Optic Cables shall be attached to connectors that are then manually inserted into adapters on the patch panel. The fiber optic may be attached by a means that is removable in the future, e.g., wire ties.
      c. All Connector Panels in each Patch Panel shall only consist of the single-mode, ceramic adapters unless where multi mode fiber strands are terminated to the fiber patch panel or specifically noted otherwise on the PLANS. For multi-mode fiber strands terminated to the patch panel, the Connector Panels shall be multi-mode, ceramic adapters.
      d. The Fiber-optic patch panels shall be enclosed in NEMA-12 lockable enclosures for indoor installation, and NEMA-4x 316-stainless steel lockable enclosures for outdoor installation, or located within the respective Main Control Panels MCP's or within PLC Cabinets, as applicable.
      e. Labeling:
         1) In addition to the device/wire tagging requirements described in Section 17200 "Instrumentation and Control Cabinets and Associated Equipment", provide additional labels as described below.
         2) Overall Connector Panel Labels: Printed on the patch panel case by the Manufacturer. Provide unique, alphanumeric designation.
         3) Connector Panel Adapter Label: Each adapter on each Connector Panel shall have clearly labeled, printed, alphanumeric designation that is unique to that Connector Panel and printed on the connector panel by the Manufacturer.
      f. Each patch panel shall be accompanied with a typed patch panel schedule with the following columns: Adapter ID, Cable Side, User Side, described as follows:
         1) adapter ID: The adapter ID shall be of the form XX-YY, where:
            a) XX is the Connector Panel identifier shown by the panel manufacturer

b) YY shall represent the adapter number within the Connector Panel.

2) Cable Side:
   a) Indicate the source of the fiber optic strands. Use the “patch panel tag”-XX-YY designation where applicable.
3) User Side:
   a) Indicates the device (PLC, patch panel, etc.) connected to the adapter.
4) A Hard Copy print out of each Patch Panel Schedule shall be provided to the OWNER and ENGINEER. A soft copy on CD-R media of the patch panel schedule shall also be provided to the OWNER and ENGINEER.

g. Employ consistent and uniform application of identifier and adapter numbering assignment to individual fiber strands along the entire span and route of each fiber optic cable.
h. Furnish and install vertical wireway along each side of each patch panel as well as horizontal wireway above and below each patch panel.

2. Each Type 1 Fiber Optic Patch Panel shall be as follows:
   a. Mounting: 19” rack mountable, with necessary brackets. Refer to the PLANS
   b. Capacity: Up to 12 connector panels
   c. Connector Panels: Minimum of six (6) connector panels, with six (6) SC-Duplex single-mode adapters of ceramic type. Furnish and install additional connector panels as required to terminate all fiber strands of cables terminated to patch panel. Refer to PLANS. Unused slots of patch panel shall be covered with blank panels. Commence termination of panels from the left side of patch panel (when viewing front/user accessible side of panel), and leave right most panels un-terminated, where applicable, as spare
   d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector
   e. Manufacturer: Corning Cable Systems LLC, Model CCH-04U, or approved equal.
3. Each Type 2 Fiber Optic Patch Panel shall be as follows:
   a. Mounting: 19” rack mountable, with necessary brackets. Refer to the PLANS
   b. Capacity: Up to 4 connector panels
   c. Connector Panels: Minimum of two (2) connector panels, with six (6) SC-Duplex single-mode adapters of ceramic type. Furnish and install additional connector panels as required to terminate all fiber strands of cables terminated to patch panel. Refer to PLANS. Unused slots of patch panel shall be covered with blank panels. Commence termination of panels from the left side of patch panel (when viewing front/user accessible side of panel), and leave right most panels un-terminated, where applicable, as spare
   d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector
   e. Manufacturer: Corning Cable Systems LLC, Model CCH-02U, or approved equal.

4. Each Type 3 Fiber Optic Patch Panel shall be as follows:
    a. Mounting: Wall mounted with necessary mounting bracket kit and any additional accessories.
    b. Capacity: Up to two (2) connector panels
    c. Connector Panels: Two (2) connector panel, with six (6) SC-Duplex single-mode adapters of ceramic type per connector panel. Unused slots of patch panel shall be covered with blank panels.
    d. All unused fiber optic connector ports shall be covered with a dust protector covering provided by manufacturer of connector.
    e. Manufacturer: Corning Cable Systems LLC, Model WCH-02P, or approved equal.
5. Fiber-Optic Patch Cords:
    a. General:
        1) Use for indoor runs of fiber cable between a fiber-optic device and a fiber-optic patch panel, between adapters on the user side of two patch panels, or between two fiber optic devices
        2) All fiber patch cords shall not consist of any splices of the fiber strands
        3) Each fiber in each patch cord shall be placed in individual tight thermoplastic buffer tubes and protected with kevlar strength members and enclosed with a thermoplastic jacket with an outer diameter of at least 2.5mm
        4) Each patch cord shall consist of at least two (2) fibers, according to the fiber count requirements of the communication devices the cable is interconnecting
        5) Each patch cord shall be pre-connectorized with the appropriate type connector by the manufacturer
        6) Provide minimum length of six feet. Provide additional length as required for the application
        7) Patch cords shall be selected with connector ends to mate/match the equipment/device/patch panel connector to which they interconnect. Duplex devices/patch panel connectors shall interconnect with duplex patch cords. Patch cord mode type (single-mode or multi-mode) shall be the same as that of device mode type and fiber patch panel connector connected fiber strand mode type with which patch cord is interconnecting
        8) Patch cord Connectors: connectors on each end of fiber optic patch cord shall mate/match that of the device/patch panel connector to which it is interconnecting on that respective end. All connectors shall have ceramic zerconia ferrule. All single-mode connecters shall be Ultra PC Polish. The connector mode type (single-mode or multi-mode) shall be the same as that of the fiber strand of the patch cord.
            a) In particular, single-mode SC-Duplex to LC-Duplex Single-mode Patch Cords shall have SC-Duplex connector on one end of the patch cord and LC-Duplex with spring on the other. The SC-Duplex connectors shall be single-mode, with ceramic zirconia ferrule and Ultra PC polish. The LC-Duplex connectors shall be single-mode, with ceramic zirconia ferrule, with an integrally mounted spring, and Ultra PC polish
            b) In particular, single-mode SC-Duplex to SC-Duplex Single-mode Patch Cords shall have SC-duplex connectors on both ends of

the patch cord. SC-duplex connectors shall be single-mode, with Ultra PC polish ceramic zirconia ferrule.

9) Single-mode Fiber Optic Patch Cords:
   a) Diameter: 8.3/125 micron
   b) Type: Single-mode Fiber
   c) Features: Adhere to the attenuation and bandwidth parameters as previously specified for fiber-optic cable and connectors as described in these specifications.
10) Manufacturer: Corning Cable Systems LLC, Model Zipcord cables, or approved equal.

2.08 ETHERNET COPPER CABLES AND CONNECTORS AND HARDWARE GENERAL SPECIFICATIONS REQUIREMENTS

A. General:
   1. Provide and install copper cables, connectors, patch panels, and cords for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components herein shall be provided as minimum for bidding purposes.
   2. Ethernet Copper Connectors: All copper Ethernet cables shall have a Category 6A boot type RJ-45 connector.
   3. The installed Ethernet copper media system (including cable, data outlets, connectors, patch cords, patch panels, etc.) shall at minimum meet the TIA/EIA-568-C.2-10 Category 6A standards.

B. Ethernet Copper Patch Cords:
   1. The Ethernet Copper Patch Cord shall be used to connect a communication device with a patch panel or Ethernet Copper Data Outlet. The Ethernet Copper Patch Cord shall also be used to connect devices directly to one another. At minimum, furnish and install copper patch cords for all Ethernet cabling between devices or between device and patch panel within the same cabinet. Refer to PLANS for required interconnections
   2. Each patch cod connector end shall be RJ-45 and shall be the Boot type connector. The connectors at each end shall be preinstalled by the Ethernet patch cord manufacturer
   3. The Patch Cord shall be unshielded twisted pair and shall be rated Category 6A
   4. The Ethernet copper cable outer jacket shall be Blue.

C. Patch panels:
   1. General:
      a. Approvals: Meet or exceed requirements for Category 6A per TIA/EIA-568-C.2-10
      b. In addition to the device/wire tagging requirements described in Section 17200 “Instrumentation and Control Cabinets and Associated Equipment”, provide additional labels as described below:
         1) Overall Connector Panel Labels: Printed on the patch panel case by the Manufacturer. Provide unique, alphanumeric designation
         2) Connector Panel Adapter Port Label: Each adapter port on each Connector Panel shall have clearly labeled, printed, alphanumeric

designation that is unique to that Connector Panel port and printed by the patch panel manufacturer

3) Terminate copper cabling to patch panel in accordance to TIA/EIA-568-C.2-10 standards
4) Label each port of each patch panel. Furnish and install TTP Continuous polyester thermal transfer label as manufactured by Tyco, with ribbon and printer by label manufacturer. Label shall be white with black lettering of minimum height ¼"

c. Each patch panel shall be accompanied with a typed patch panel schedule with the following columns: Adapter ID, Cable Side, User Side, described as follows:
   1) adapter ID: The adapter ID shall be of the form XX-YY, where:
      a) XX is the Connector Panel identifier shown by the panel manufacturer
      b) YY shall represent the adapter number within the Connector Panel
   2) Cable Side: Indicate the source of the cable. Use the "patch panel tag"-XX-YY designation where applicable
   3) User Side: Indicates the device (PLC, patch panel, etc.) connected to the adapter
   4) A Hard Copy print out of each Patch Panel Schedule shall be provided to the OWNER and ENGINEER. A soft copy on CD-R media of the patch panel schedule shall also be provided to the OWNER and ENGINEER
   5) Employ consistent and uniform application of identifier and adapter numbering assignment to Ethernet Copper cables along the entire span and route of each copper cable.
d. For 19" rack mount patch panels, furnish and install vertical wireway along each side of each patch panel as well as horizontal wireway above and below each patch panel.
e. For the modular patch panels, label each port of the patch panel as "Ax" for channel "A" cabling or "Bx" for channel "B " cabling and label simply as "x" for cabling not specific to a channel, where x is a number starting at 1 and incrementing by one for each port. The ports shall be labeled in ascending order from left to right, top to bottom.

2. Each Type 1 patch panel shall be as follows:
   a. Construction: Metal, primed and painted with manufacturer's standard black finish.
   b. Quantity of Ports: minimum 24.
   c. Miscellaneous: Color coded front port labeling.
   d. Mounting: 19" rack mountable. Mount on 19" rack, with all necessary brackets and hardware. Refer to the PLANS.
   e. Manufacturer: Siemon, Panduit, Hubbell, CommScope, or approved equal.
3. Each Type 2 patch panel shall be as follows:
   a. Construction: High impact thermoplastic with clear plastic labeling window
   b. Operating Temperature: +14° F to +140° F
   c. Quantity of ports: Minimum 2, furnish and install quantity of jacks and mounting modules to satisfy quantity of ports.

d. Labeling: Label each port with printed minimum 1/4” high lettering using indelible moisture and heat resistant marking system, black on white. In addition, label the overall patch panel with tag using phenolic tagging.
e. Mounting: DIN-Rail mountable
f. Manufacturer: Signamax KI-DIN-RMM-SL Keystone Industrial DIN-Rail Mounting Module for Keystone Jacks, with side lids.
g. Keystone Jacks:
1) Jack Type: 8-position, 8 contact RJ45 style
2) Transmission Performance: Category 6A
3) Transmission Media: Unscreened twisted pair (U/UTP)
4) Wire Gauge: 22-24 AWG
5) Color: Blue
6) Manufacturer: Signamax Category 6A MT-Series High Density Keystone Jack.

4. Each Type 3 patch panel shall be as follows:
a. Construction: High impact thermoplastic with clear plastic labeling window
b. Operating Temperature: +14° F to +140° F
c. Quantity of ports: Minimum 12, furnish and install quantity of jacks and mounting modules to satisfy quantity of ports.
d. Labeling: Label each port with printed minimum 1/4” high lettering using indelible moisture and heat resistant marking system, black on white. In addition, label the overall patch panel with tag using phenolic tagging.
e. Mounting: DIN-Rail mountable
f. Manufacturer: Signamax KI-DIN-RMM-SL Keystone Industrial DIN-Rail Mounting Module for Keystone Jacks, with side lids.
g. Keystone Jacks:
1) Jack Type: 8-position, 8 contact RJ45 style
2) Transmission Performance: Category 6A
3) Transmission Media: Unscreened twisted pair (U/UTP)
4) Wire Gauge: 22-24 AWG
5) Color: Blue
6) Manufacturer: Signamax Category 6A MT-Series High Density Keystone Jack.

5. Each Type 4 patch panel shall be as follows:
a. Construction: High impact thermoplastic with clear plastic labeling window
b. Operating Temperature: +14° F to +140° F
c. Quantity of ports: Minimum 4, furnish and install quantity of jacks and mounting modules to satisfy quantity of ports.
d. Labeling: Label each port with printed minimum 1/4” high lettering using indelible moisture and heat resistant marking system, black on white. In addition, label the overall patch panel with tag using phenolic tagging.
e. Mounting: DIN-Rail mountable
f. Manufacturer: Signamax KI-DIN-RMM-SL Keystone Industrial DIN-Rail Mounting Module for Keystone Jacks, with side lids.
g. Keystone Jacks:
1) Jack Type: 8-position, 8 contact RJ45 style
2) Transmission Performance: Category 6A
3) Transmission Media: Unscreened twisted pair (U/UTP)
4) Wire Gauge: 22-24 AWG

5) Color: Blue
6) Manufacturer: Signamax Category 6A MT-Series High Density Keystone Jack.

6. Each Type 5 patch panel shall be as follows:
   a. Construction: Metal, primed and painted with manufacturer's standard black finish.
   b. Quantity of Ports: minimum 48.
   c. Miscellaneous: Color coded front port labeling.
   d. Mounting: 19" rack mountable. Mount on 19" rack, with all necessary brackets and hardware. Refer to the PLANS.
   e. Manufacturer: Siemon, Panduit, Hubbell, CommScope, or approved equal.

D. Copper Ethernet Data Communication Cabling:
   1. Copper Ethernet Communication Cabling shall be used to interconnect copper patch panels with each other, or to interconnect Ethernet data outlets to copper patch panels.
   2. The copper Ethernet cabling shall be unshielded, twisted pair, rated Category 6A cabling.
   3. Agency Compliance: TIA/EIA-568-C.2, TIA/EIA-568-C.2-10 Category 6A, IEEE 802.3an 10GBASE-T Ethernet, UL Listed
   4. Number of Pairs: Four
   5. Wire: #23 AWG Bare Copper
   6. Type of Conductors: Solid copper conductors, twisted
   7. Individual Conductor Insulation: Minimum 300 volt polyolefin
   8. Individual Conductor Insulation Color: White/Blue Stripe, Blue, White/Orange Stripe, Orange, White/Green Stripe, Green, White/Brown Stripe, Brown
   9. Overall Jacket: PVC, include ripcord
   10. Overall Jacket Color: Blue
   11. Manufacturer: Belden 10GX32, or approved equal.

E. Copper Ethernet Cable System Testing:
   1. After installation of Copper Ethernet Cable System, ICS shall perform testing of the cable system to assure compliance of the installed system with the TIA/EIA-568-C.2-10 Category 6A requirements. Testing shall be performed for all installed copper cable systems, including used and unused links, from end-to-end, including all data outlets, connectors, patch panels, patch cords, etc
   2. Copper Ethernet Cable System Test reports shall be submitted to the engineer and owner for review and approval. The test report shall document, for each copper data link, description of the link and components therein, the testing method used, test results, and demonstrate compliance with TIA/EIA-568-C.2-10 of the link. If any installed link does not meet the TIA/EIA-568-C.2-10 Category 6A requirements, ICS shall repair/modify link to assure it is compliant with TIA/EIA-568-C.2-10 Category 6A standard at no additional cost to the owner.

2.09 CONFIGURATION SYSTEM

A. Provide a configuration system, including hardware necessary to allow Engineer configuration of and programming of the PLC system. PLCs equipment provided as

part of the Configuration System shall be fully compatible with the DCS equipment provided for this system.

B. Ship and temporarily install the Configuration System at the Engineer's designated facility.

C. Include at least the following components for the Configuration System:
   1. All proposed Programmable Logic Controllers (PLCs), including all racks, power supplies, microprocessor modules, I/O modules, communication modules, remote I/O modules, etc.
   2. All proposed Remote I/O units, including all racks, power supplies, I/O modules, communication modules, remote I/O modules, etc.
   3. All Communications interface hardware, cabling, and fiber optics electronics for PLC-to-PLC interface, and PLCs to programmer PC interface, OIU interface, etc.
   4. All SCADA allowance equipment, including switches, laptops, desktop computers, and server computers. The SCADA Allowance equipment is to be delivered separately and at later date from the remainder of the configuration system.
   5. Provide the following equipment for each PLC Type used: PLC CPU module, two (2) NOE modules, 16 slot rack, power supply, and two (2) digital input, two (2) digital output, two (2) analog input, two (2) RTD modules if the RTD module of this type is shown on the drawings, and two (2) analog output modules if the analog output module of this type is shown on the drawings. These equipment shall be independent of the PLC equipment to be installed in the field and shall in no way impede the ICS progress of work in wiring to the PLC modules. These may be counted among the spare PLC equipment to be purchased.
   6. All necessary cabling to interconnect the equipment at the engineer's site as follows:
      a. The programming cabling between the PLC and the Engineer's computer shall, at minimum, consist of four (4) USB programming cables, each of 12 foot length minimum
   7. Provide the following per specifications, to be included with the configuration system (These units may be counted amongst the spare units):
      a. One (1) GE Multilin EPM 9700 (Transducer Module) with advanced software option complete with three line LED combination display and keypad Model P40NPLUS. Furnish and install all required cabling to power the units and to interconnect display with EPM unit
   8. Provide all Ethernet Switches
   9. One OIU Computer, of each type used, complete with all accessories and software
   10. One (1) laptop complete with all accessories and software
   11. Provide 19" rack(s) and install PLC racks and other configuration equipment on 19" rack(s). For each 19" rack, secure rack to base with four (4) lockable, caster wheels that shall allow the cabinet to be pushed/carted forward, backward, and rotated at least 90 degrees. Overall rack assembly height shall not exceed 60".
   12. Prior to assembly and delivery of configuration system, submit to engineer a drawing detailing the front and back elevations of proposed arrangement of PLC equipment on 19" rack(s). Upon approval of submittal, contractor is to

then configure rack according to approved submittal and ship configuration system to Engineer's location.

13. When directed by the Engineer, recreate and ship Configuration System from the Engineer's designated facility to Owner's facility.
14. Provide property and shipping insurance and include the Engineer and Owner as insured. Insure against fire and all-risk for physical loss and damage. The Owner and Engineer will not provide insurance for the Configuration System.

2.10 SCADA ALLOWANCE EQUIPMENT

A. General:
   1. Certain types of computer systems shall be furnished and installed under this project. Due to changing technology, the hardwire requirements will be provided to the contractor after bid award.
   2. The budget for the purchase of this hardware shall be from the SCADA Allowance budget. See specification section 01020.
   3. For those equipment identified as SCADA allowance in the PLANS, the Contractor shall include as part of the base bid the effort to install and transport each such equipment.
   4. For those equipment identified as SCADA allowance in the PLANS, the Contractor shall include as part of the base bid the effort and materials to tag each piece of equipment as well as to terminate all wiring, including power wiring and Ethernet cabling, for each such equipment.
   5. All software shall be registered in the name of the Owner.
   6. All GE iFIX software shall have a minimum 2 year support contract.

B. SCADA Allowance Laptop Programming Computer:
   1. The hardware for this item shall be purchased under the SCADA Equipment Allowance.
   2. The software for this item shall be furnished as part of the SCADA Equipment Allowance and shall be provided to the owner. Two (2) laptops may be assumed. The software shall be as follows for each laptop:
      a. Office 2020 Professional Perpetual license. The software shall be retail package version. OEM software shall not be acceptable.

C. SCADA Allowance SCADA Server Computer:
   1. The hardware for this item shall be purchased under the SCADA Equipment Allowance. Refer to PLANS.
   2. The software for this item shall be furnished as part of the base bid and shall be provided to the owner. Two (2) server computers may be assumed for bidding purposes. The software shall be as follows for each server:
      a. Office 2020 Professional Perpetual license. The software shall be retail package version. OEM software shall not be acceptable.
      b. GE iFIX SCADA unlimited tag runtime latest version with failover and with media

D. SCADA Allowance Domain Server Computer:
   1. The hardware for this item shall be purchased under the SCADA Equipment Allowance. Refer to PLANS.

2. The software for this item shall be furnished as part of the base bid and shall be provided to the owner. One (1) domain server computer may be assumed for bidding purposes. The software shall be as follows for each server:
    a. Office 2020 Professional Perpetual license. The software shall be retail package version. OEM software shall not be acceptable.

E. SCADA Allowance Data Mart Historical Data Computer:
1. The hardware for this item shall be purchased under the SCADA Equipment Allowance. Refer to PLANS.
2. The software for this item shall be furnished as part of the base bid and shall be provided to the owner. One (1) domain server computer may be assumed for bidding purposes. The software shall be as follows for each server:
    a. Office 2020 Professional Perpetual license. The software shall be retail package version. OEM software shall not be acceptable.

F. SCADA Allowance Engineering Workstation Computer:
1. The hardware for this item shall be purchased under the SCADA Equipment Allowance. Refer to PLANS.
2. The software for this item shall be furnished as part of the base bid and shall be provided to the owner. One (1) computer may be assumed for bidding purposes. The software shall be as follows for each server:
    a. Office 2020 Professional Perpetual license. The software shall be retail package version. OEM software shall not be acceptable.
    b. GE iFIX SCADA development unlimited tag latest version with media.

G. SCADA Allowance Desktop Computer:
1. The hardware for this item shall be purchased under the SCADA Equipment Allowance. Refer to PLANS.
2. The software for this item shall be furnished as part of the base bid and shall be provided to the owner. Four (4) workstations may be assumed for bidding purposes. The software shall be as follows for each workstation:
    a. Office 2020 Professional Perpetual license. The software shall be retail package version. OEM software shall not be acceptable.
    b. GE iFIX client runtime latest version with media

H. SCADA Allowance Ethernet Switch:
1. The hardware for this item shall be purchased under the SCADA Equipment Allowance. Refer to this specification section for the specific types of Ethernet switches that are to be purchased under the SCADA allowance.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. The ICS shall furnish labor, materials, equipment, and incidentals required to install the system in accordance with specification section 17100 and 17600.

B. The ICS shall be responsible for ensuring that field wiring for power and signal circuits is correct and wired in accordance with best industry practice. Also, the ICS

shall be responsible for providing all necessary system grounding to insure a satisfactory functioning installation.

C. Remote access shall NOT be allowed to the Owner's supervisory control and data acquisition (SCADA) system or SCADA components.

3.02 FIBER-OPTIC SYSTEM AND ETHERNET SYSTEM COPPER CABLING- SOURCE QUALITY CONTROL

A. Fiber Optic Splice-on Connector Termination:
   1. The specified splice-on connectors shall be terminated using a fusion splicer and splicing oven with fiber holders to ensure the fiber cables are machine aligned prior to splicing. The splicing oven shall be the Fujikura 12S Fusion Splicer, or approved equal. Splicer and oven shall be compatible with the splice-on connectors. The loss of the fusion splice shall be no greater than 0.1 dB.

B. Fiber Optic On-Site Testing:
   1. General: The ICS shall provide all equipment, instrumentation, and supplies necessary to perform all testing. The OWNER/ENGINEER shall have the option to witness and participate actively in the On-Site tests performed by the ICS firm.
   2. Cables shall be tested with an Optical-Time-Domain Reflectometer "OTDR", as described hereinafter. The OTDR shall be designed to test the type of cable required for the project and shall include a laser light source used for transmitting test signals through the fiber under test. Contractor shall use launch cables of minimum length of 500 feet and tail cords (receiver cables) when performing testing with the OTDR. OTDR test wavelengths shall be as follows:
      a. Single-mode cable: 1310nm and 1550nm
      b. Multi-mode cable: 850nm and 1300nm.
   3. OTDR test results shall include the following, at minimum:
      a. Cable tested
      b. Fiber number
      c. Direction of test
      d. Wavelength
      e. Reference power reading,
      f. Total length of fiber
      g. Attenuation of the fiber
      h. Power loss (in dB) across the length of fiber cable. The results shall also show the individual numerical dB loss values of the loss across each connector, each splice, and each fiber cable.
      i. OTDR traces, legibly plotted The traces shall be displayed on a trend chart with size 7" long and 5" high. The trace shown should be zoomed/scaled so that it spans the area of the displayed chart, and the vertically and horizontal axis labels adjusted accordingly.
      j. Additional information as necessary to determine insertion loss across the connectors and cables.
   4. Pre-installation testing: Prior to the physical placement of the fiber optic cable, each fiber shall be OTDR tested on-Site, while on the spool. Submit test results for approval prior to cable installation.

5. Post-installation Testing:
    a. Separate OTDR tests shall be performed on all installed fibers (both used and unused fibers) as follows, with all test results submitted accordingly:
        1) Cable after connectorization. Perform test from both ends of the cable, at each patch panel connector attached to the cable's fiber strands.
    b. Fiber end-to-end attenuation testing
        1) Fiber end-to-end attenuation testing shall be performed on all installed fibers (both used and unused fibers) after connectorization from both ends of the cable.
        2) These tests shall utilize a stabilized light source and optical power meter. The attenuation tests shall be performed at wavelengths of 1310 nm and 1550 nm for Single-mode cable and 850nm and 1300nm for Multi-mode cable. Documented results to be provided shall include the cables tested, fiber number, direction of tests, wavelength, the power loss (in dB) across the length of fiber cables tested, and reference power reading.
    c. Fiber device-to-device attenuation testing
        1) This testing shall be performed after all necessary patch fiber patch cords have been installed in the system.
        2) This test shall be performed on all renovated fiber optic links between fiber optic devices. The test shall be conducted only after all necessary patch cords to be used in the final system to create the link between devices are properly installed. The tests shall be performed from both ends of the link. The test should include all installed patch cords in the link, including the end patch cords that are to connect to the switches themselves.
        3) These tests shall utilize a stabilized light source and optical power meter as well as OTDR. The attenuation tests shall be performed at wavelengths of 1310 nm and 1550 nm for Single-mode cable and 850nm and 1300nm for Multi-mode cable. Documented results to be provided shall include the cables tested, fiber number, direction of tests, wavelength, the power loss (in dB) across the length of fiber cables tested, and reference power reading and OTDR results, as identified in these specifications.

C. Copper Ethernet Cable System Testing:
    1. After installation of Copper Ethernet Cable System, ICS shall perform testing of the cable system to assure compliance of the installed system with the TIA/EIA-568-C.2-10 Category 6A requirements. Testing shall be performed for all installed copper cable systems, including used and unused links, from end-to-end, including all data outlets, connectors, patch panels, patch cords, etc
    2. Copper Ethernet Cable System Test reports shall be submitted to the engineer and owner for review and approval. The test report shall document, for each copper data link, description of the link and components therein, the testing method used, test results, and demonstrate compliance with TIA/EIA-568-C.2-10 of the link. If any installed link does not meet the TIA/EIA-568-C.2-10 Category 6A requirements, ICS shall repair/modify link to assure it is compliant with TIA/EIA-568-C.2-10 Category 6A standard at no additional cost to the owner.

3.03 TESTS (GENERAL)

A. Refer to Section 17100.

3.04 INITIAL ON-SITE SYSTEM DEMONSTRATION TESTS

A. Programmable Logic Controllers PLCs:
   1. Test all loop-specific functions and demonstrate all I/O Points.
   2. Test all non-loop-specific functions including, but not limited to, the following:
      a. Failure Mode and Backup Procedures: Power failure, auto restart, retentive outputs.
   3. Refer to Section 17100 for additional test requirements.

3.05 OPERATIONAL READINESS TEST (ORT) AND PERFORMANCE ACCEPTANCE TESTS (PAT)

A. Refer to Section 17100.

PART 4 TRAINING

4.01 GENERAL

A. Provide a training program for the OWNER's personnel to address all equipment provided. The training program shall meet the specific needs of the OWNER and include the following subjects, at a minimum:
   1. Hardware
      a. Specific training for the actual hardware configuration provided
      b. Test, adjustment, calibration, troubleshooting, and component replacement procedures.
   2. Software:
      a. Operate the equipment on a day-to-day basis.
      b. Make programming changes for all aspects of programming/configuration/functionality.
      c. Configuration, troubleshooting, software installation procedures.
      d. Assist the hardware maintenance technicians in diagnosing problems with the equipment.
      e. Classes shall be designed for students having the equivalent of a one-semester class on personal computers, but no professional programmable controller programming experience, OIU programming experience, or Ethernet switch configuration experience.

B. Additional training program requirements:
   1. Training duration:
      a. Hardware: A minimum of two (2) days, each of eight (8) normal working hours.
      b. Provide additional time as required by the OWNER.
   2. Training Location: OWNER's designated facility located in Austin, Texas. Include all associated expenses.

3. Shift Quantity: Total of one shift, at minimum, with a minimum ten (10) of the Owners personnel for each shift. Provide the training coordinated with the OWNER's schedule.
4. Personnel attending the training will be technical, managerial, administrative, engineers, and maintenance type personnel. The training shall accommodate instruction methods and materials accordingly.

4.02 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION