LOUDOUN WATER
BRWRF EXPANSION PROJECT
Sidestream Deammonification System
Request for Proposals

SECTION 00003S

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SUMMARY OF GOODS AND SERVICES

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1.01 THE REQUIREMENT

A. Description of Work:

1. The Offeror shall provide Goods and Services for the Sidestream Deammonification System (SDS) for the Broad Run Water Reclamation Facility (BRWRF) 16.5 MGD Design Flow Expansion Project. The Offeror shall provide Goods and Services for two parts. Part 1 –shall be engineering services to provide submittals and other information for the selected system in support of design efforts by others (Design Engineer), Part 2 – shall be Goods and Services for the Expansion Project. This section includes an overall summary of the responsibilities of the Offeror and its relation to Loudoun Water, Engineer, and the Contractor awarded the Expansion Project. It does not supersede the specific requirements of the RFP.

2. Project Background:

a. The Goods and Services consist of furnishing a Sidestream Deammonification System required for the Broad Run Water Reclamation Facility (BRWRF). The Goods and Services also consist of furnishing offeror-trained personnel for the installation, commissioning, acceptance testing, training, and operations assistance as specified.

b. The following narrative is provided as a general description of the project background and goals. Design or operating parameters and proposed improvements beyond those that relate to this project are provided herein as information based upon the current understanding of the project and shall not constitute the basis of design and/or operation of the current or proposed facilities.

i. Loudoun Water has recently completed the BRWRF Expansion Project Master Plan, which identified the opportunity to implement Sidestream Deammonification to reduce the total nitrogen load to the mainstream nutrient removal process.

ii. Reducing the sidestream nitrogen load will help to increase the nutrient removal capacity and reliability of the mainstream nutrient removal facilities.

3. Supply of goods to be provided by the Offeror is identified in the RFP Documents and in the Reference Drawings and shall include, but is not limited to the following:

a. Sidestream Deammonification System equipment including aeration system, blowers, mixers, biomass separation and retention system, pumps, and other internal equipment.

b. Programmable Logic Controllers and remote I/O panels for the Sidestream Deammonification Equipment including control programming for equipment provided by others but required for the operation of the Sidestream Deammonification System as shown on the Reference Drawings.

c. Human Machine Interface for Sidestream Deammonification Equipment.

d. Field mounted instrumentation as specified in Section 11000S and Division 17S.

4. The Services supplied by the Offeror shall include, but are not limited to the following:

a. Design of the Goods provided by the Offeror.

b. Submittal of Shop Drawings and Samples.

c. General arrangement drawings of the Sidestream Deammonification System.

d. Programmable Logic Controller (PLC) panel layout drawings.

e. Assistance to Loudoun Water and the Engineer during the design.

f. To coordinate with the Engineer throughout the design process of the Sidestream Deammonification System.

g. Design and programming of the programmable logic controller(s) and human machine interface system (PLC, Remote I/O, and HMI) for the Sidestream Deammonification System as delineated on the P&IDs and including, but not limited to:

i. Design and programming of operator interface screens, data logging, and reporting capabilities.

ii. Coordination between Offeror-provided PLC and other Loudoun Water equipment interfaces.

iii. Programming of PLC, Remote I/O, and HMI supplied with the control system.

iv. Factory acceptance testing of PLC system.

h. Operational and Maintenance Manuals for all equipment provided by the Offeror.

i. Scheduling of equipment delivery, witnessing unloading and unpacking of Offeror supplied equipment, and inspecting equipment condition.

j. Equipment and services for Biological System Start-up and Performance Acceptance Testing including operation of the system.

k. Training of the Owner's Operators.

l. Oversee the setting and anchoring of equipment in the deammonification reactor basins.

m. Review of equipment installation.

n. Calibration of Offeror supplied instrumentation and technical support during the Loop testing (loop testing specification is not included in this RFP and shall be provided in the Specifications for the Expansion Project).

o. Correction Period Assistance.

p. Sidestream Deammonification System Warranty.

PART 2– PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -

SECTION 01302S

SUBMITTALS

PART 1 -- GENERAL

1.01 GENERAL

A. The Offeror shall provide Goods and Special Engineering services for two different parts. Part 1 – shall be special engineering services to provide shop drawings and other information for the selected system in support of design efforts by others (Design Engineer), and Part 2 – goods and special services for the Broad Run Water Reclamation Facility (BRWRF) 16.5 MGD Design Flow Expansion Project (Part 2 –Expansion Project). This section is related to Part 1 – Special Engineering Services and specifies the methods and requirements for submittals. Additional requirements are contained in the RFP General and Special Conditions. Specific requirements for Shop Drawings are denoted in the applicable Sections.

B. Failure to provide the Shop Drawings as required by this Section within the allocated time shall constitute a failure of the Offeror to provide Special Engineering Services in accordance with the requirements of the Contract. The Offeror shall be assessed Liquidated Damages in accordance with Section 5.8.4, Paragraph 3 of the Procurement Agreement until acceptable Shop Drawings have been provided.

C. Satisfactory Part 1 submittals shall receive a disposition of “For Design Only.” Submittals shall be resubmitted through the Contractor in Part 2, Expansion Project in conformance with Section 01300 of the Expansion Project Contract Documents for review by the Engineer for construction. No materials shall be released for manufacturer until approval in Part, Expansion Project.

1.01 SUBMITTAL PROCEDURES

A. Unless otherwise specified, all submittals:

1. Shall consist of book marked and searchable PDFs to Engineer and Owner.

2. Submittal comments will be returned by the Engineer or Owner with comments or other necessary response within thirty (30) days after receipt by the Owner, unless otherwise specified.

B. Certain submittals require extended review times or special submittal procedures as specified. The Owner reserves the right to modify the procedures and requirements for submittals, as necessary to accomplish the specific purpose of each submittal. Contractor shall direct inquiries to Engineer regarding the procedure, purpose, or extent of any submittal.

C. Review, acceptance, or approval of substitutions, schedules, Shop Drawings, O&M manuals, lists of materials, or procedures submitted or requested by Offeror shall not add to the Contract Price or Contract Time, and additional costs or time which may result therefrom shall be solely the obligation of Offeror. Owner is not responsible to provide engineering or other services to protect Offeror from additional costs accruing from such approvals.

1.02 SHOP DRAWINGS

A. Shop Drawings include, but are not limited to layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc. Offeror shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Shop Drawings required and necessary under this Contract and to fulfill all other requirements of his Contract.

B. Offeror shall submit for review by the Engineer Shop Drawings for all fabricated work and for all manufactured items required to be furnished by the Contract Documents.

C. Structural and all other layout Drawings prepared specifically for the Project shall have a plan scale of not less than 1/4-inch = 1 foot.

D. Where manufacturer's publications in the form of catalogs, brochures, illustrations or other data sheets are submitted in lieu of prepared Shop Drawings, such submittals shall specifically indicate the item for which approval is requested. Identification of items shall be made in ink, and submittals showing only general information are not acceptable.

E. For all tagged devices supplied, the Offeror shall utilize the “Asset Loader Template” that matches the Tag to the appropriate equipment manual. The Asset Loader Template shall be provided for each section submitted.

1. The asset loader template shall include the pertinent information associated with the equipment including tag number, description, functional name location, component equipment model, part number, size, materials, accessories and range. The Asset Loader Template shall be provided in the form of a Microsoft Excel (.XLSX) spreadsheet.

2. Provide a separate listing for all Sidestream Deammonification System Equipment, including asset loader templates with Section 11200S. Equipment that is not considered part of the Sidestream Deammonification System shall be submitted with the appropriate Division 11, Division 13 or Division 15 submittal.

1.03 OFFEROR RESPONSIBILITIES

A. Provide submittals promptly in accordance with the Contract Times specified in the RFP Scope of Work and the RFP Procurement Agreement Times.

B. All submittals from subcontractors, manufacturers or suppliers shall be sent directly to the Offeror for review. Offeror shall thoroughly check all Drawings for accuracy and conformance to the intent of the Contract Documents. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors, manufacturers, or suppliers by the Offeror for correction before submitting to them to the Engineer.

C. All submittals shall be organized, dated, properly labeled and consecutively numbered. Information on the cover sheet/label shall indicate Specification Section, Drawing number, subcontractor's, manufacturer's or supplier's name and the name or type of item the submittal covers. Each part of a submittal shall be marked and tabulated.

1. A 10-character submittal identification numbering system shall be used:

   a. The first character shall be an alpha character as follows:

      D - Shop Drawings

      P - Product Data

      L - Layout and Installation Drawings

      M - Operation and Maintenance Manual

      R - Certification, Test Results, and ISA Forms

      S – Sample

      U - Test Procedures

   b. The next five digits shall be the applicable Specifications Section Number.

   c. The next three digits shall be the numbers 001-999 to sequentially number each separate item or drawing submitted under each Specification Section.

   d. The last character shall be a letter, A-Z, indicating the submission, or resubmission of the same Drawing, i.e., A-1st submission, B-2nd submission, C-3rd submission, etc. A typical submittal number would be as follows:

      D-15260-008-B

D	=	Shop Drawing
11122	=	Specification Section for Progressive Cavity Pumps
008	=	The eighth sequential submittal under this specification section
B	=	The second submission (first resubmission) of that particular Shop Drawing.

   e. NOTE: The grouping of data under a general specification section rather than the specific section in which it is referenced is prohibited. (Such as including all electrical submittals in one package with a common submittal number D-16000-001-A.) If data from more than one section is submitted simultaneously, one submittal number will be assigned for each relevant specification section.

D. Shop Drawings shall be submitted as a single complete package for any operating system and shall include all items of equipment and any mechanical units involved or necessary for the functioning of such system. Where applicable, the submittal shall include elementary wiring diagrams showing circuit functioning and necessary interconnection wiring diagrams for construction.

E. All submittals shall be thoroughly reviewed by the Offeror for accuracy and conformance to the intent of the contract documents before being submitted to the engineer and shall bear the offeror's acknowledgement certifying that they have been so reviewed (either in the submittal itself, or in the Offeror’s transmittal of such submittal). Submittals without the Offeror's acknowledgement of approval will not be reviewed by the Engineer and will be returned to the Offeror.

F. If the submittals contain any departures from the Contract Documents, specific mention thereof shall be made in the Offeror's letter of transmittal. The review of submittals provided without clear annotation of any proposed departure from the contract requirements shall not constitute approval of the departure.

G. Where errors, deviations, and/or omissions are discovered at a later date in any of the submittals, the Engineer's prior review of the submittals does not relieve the Offeror of the responsibility for correcting all errors, deviations, and/or omissions.

1.04 PROCEDURE FOR REVIEW

A. Submittals shall be transmitted in sufficient time to allow the Engineer at least thirty (30) working days for review and processing.

B. Submittal shall be accompanied by a letter of transmittal, in duplicate, containing date, project title, Contractor's name, number and titles of submittals, notification of departures and any other pertinent data to facilitate review.

C. Refer to the RFP General and Special Conditions.

D. Submittals will be annotated by the Engineer in one of the following ways:

1. "For Design Only” (FDO) – submittal conforms to the design intent but shall be resubmitted as part of Part 2, Expansion Project through the Contractor for review and approval for manufacturing and construction.

2. "Approved as Submitted” (AAS) - no exceptions are taken

3. "Approved as Noted” (AAN) - minor corrections are noted and shall be made.

4. “Approved as Noted – Confirm” (AANC) - some corrections are noted and a partial resubmittal or additional information are required as specifically requested.

5. "Revise and Resubmit" (R&R) - major corrections are noted and a full resubmittal is required.

6. "For Information Only – Not Reviewed” (FIO) – submittal was received and was distributed for record purposes without review.

7. ”Not Approved” (NA) - Based on the information submitted, the submission is not in conformance with the Contract Documents. The deviations from the Contract

Documents are too numerous to list and a completely revised submission of the proposed equipment or a submission of other equipment is required.

E. If a submittal is satisfactory to the Engineer, the Engineer will annotate the submittal "Approved as Submitted", "Approved as Noted" or Approved as Noted - Confirm In the case of “Approved as Noted – Confirm” a partial resubmittal or additional information are required as specifically requested.

F. If a full resubmittal is required, the Engineer will annotate the submittal "Revise and Resubmit".

G. Offeror shall revise and resubmit submittals as required by the Engineer until submittals are acceptable to the Engineer. It is understood by the Offeror that Owner will charge the Contractor review fees for each resubmittal beyond the first resubmittal in accordance with General Conditions Article 6.17 of the Expansion Project Contract.

H. Acceptance of a Working Drawing by the Engineer will constitute acceptance of the subject matter for which the Drawing was submitted and not for any other structure, material, equipment or appurtenances indicated or shown.

I. If the Offeror considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Offeror shall give written notice thereof to Loudoun Water and Engineer within seven (7) working days of the shop drawing being returned.

J. When the shop drawings have been completed to the satisfaction of Loudoun Water and Engineer, the Offeror shall carry out the design in accordance therewith and shall make no further changes therein except upon written instructions from Loudoun Water and Engineer.

1.05 ENGINEER'S REVIEW

A. Engineer's review of the Contractor's submittals shall in no way relieve the Contractor of any of his responsibilities under the Contract. An acceptance of a submittal shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications.

B. Engineer's review will be confined to general arrangement and compliance with the Contract Drawings and Specifications only, and will not be for the purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of trades, etc.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

-END OF SECTION-

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SECTION 01600S

MATERIALS AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and Install

1. Where the words "furnish", "provide", "supply", "replace", or "install" are used, whether singularly or in combination, they shall mean to furnish and install, unless specifically stated otherwise.

2. In the interest of brevity, the explicit direction "to furnish and install" has sometimes been omitted in specifying materials and/or equipment herein. Unless specifically noted otherwise, it shall be understood that all equipment and/or materials specified or shown on the Drawings shall be furnished and installed under the Contract as designated on the Drawings.

B. Concrete Foundations for Equipment

1. Contractor shall provide all concrete foundations shown, specified or required for all equipment furnished under their respective Contract.

2. Anchor bolts and templates for equipment foundations shall be furnished under the respective Contracts for installation by the respective Contractor. The General Contractor shall cooperate with the respective Contractors to secure a satisfactory installation and to maintain the schedule of construction.

3. All concrete foundations for equipment shall be treated, by the respective Contractor, with an approved sealer to prevent oil from seeping into the concrete.

C. Engineering Design Manual (EDM)

1. All work shall conform to Loudoun Water's Engineering Design Manual, [October 2016 Edition, as amended through November 2017], which includes Appendix F (Standard Details) and Appendix G (Approved Materials List). The EDM is available at www.loudounwater.org. The Project Manual and Drawings may include additional requirements pertaining to the work.

1.02 EQUIPMENT AND MATERIALS

A. All equipment, materials, instruments or devices incorporated in this project shall be new and unused, unless indicated otherwise in the Contract Documents. Equipment and materials to be incorporated into the work shall be delivered sufficiently in advance of their installation and use to prevent delay in the execution of the work, and they shall be delivered as nearly as feasible in the order required for executing the work.

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B. The Contractor shall protect all equipment and materials from deterioration and damage, including provisions for temporary storage buildings as needed. Storage of equipment and materials shall be in locations completely protected from flooding, standing water, excessive dust, falling rock, brush fire, etc. Storage areas shall be located sufficiently distant from all construction activities and the movement of construction vehicles to minimize the potential for accidental damage. Any equipment or materials of whatever kind which may have become damaged or deteriorated from any cause shall be removed and replaced by good and satisfactory items at the Contractor's expense for both labor and materials.

1.03 INSTALLATION OF EQUIPMENT

A. Equipment and materials shall be installed in accordance with the requirements of the General Conditions, Supplemental Conditions and the respective Specification Sections.

B. Concrete foundations for equipment shall be of approved design and shall be adequate in size, suitable for the equipment erected thereon, properly reinforced, and tied into floor slabs by means of reinforcing bars or dowels. Foundation bolts of ample size and strength shall be provided and properly positioned by means of suitable templates and secured during placement of concrete. Foundations shall be built and bolts installed in accordance with the manufacturer's certified drawings.

C. Before mounting equipment on a foundation, the Contractor shall clean the top surface; if necessary, rough it with a star chisel and clean again; and clean out all foundation bolt sleeves. The Contractor shall provide a sufficient number of steel plate shims about 2-inches wide and 4-inches long, and of a varying thickness from 1/8 to 1/2-inch. A combination of these shims shall be placed next to each foundation bolt to bring the bottom of the bedplate or frame about 1/8-inch above the final setting. The equipment shall be lowered by changing the combination of shims. Using brass shim stock of various thicknesses, continue to level the equipment a little at a time and in rotation until it is at the correct elevation in both directions. When the equipment is level, tighten down on the foundation bolts a little at a time in rotation to make certain the equipment remains level and does not shift on the shims. A preliminary alignment check shall be made before grout is placed.

D. Equipment shall be set, aligned and assembled in conformance with manufacturer's drawings or instructions. Run out tolerances by dial indicator method of alignment shall be plus or minus .002-inches, unless otherwise approved by the Engineer.

E. All blocking and wedging required for the proper support and leveling of equipment during installation shall be furnished by the Contractor. All temporary supports shall be removed, except steel wedges and shims, which may be left in place with the approval of the Engineer.

F. Each piece of equipment or supporting base, bearing on concrete foundations, shall be bedded in grout. The Contractor shall provide a minimum of 1-1/2-inch thick grouting under the entire baseplate supporting each pump, motor drive unit and other equipment. Grout shall be non-shrink grout, as specified under Section 03600, Grout.

G. When motors are shipped separately from driven equipment, the motors shall be received, stored, meggered once a month, and the reports submitted to the Engineer. After driven equipment is set, the motors shall be set, mounted, shimmed, millrighted, coupled and connected complete.

1.04 CONNECTIONS TO EQUIPMENT

A. Connections to equipment shall follow manufacturer's recommendations as to size and arrangement of connections and/or as shown in detail on the Drawings or approved Shop Drawings. Piping connections shall be made to permit ready disconnection of equipment with minimum disturbance of adjoining piping and equipment.

B. The Electrical Contractor or General Contractor if no electrical contract exists shall be responsible for bringing proper electrical service to each item of equipment requiring electrical service as shown on the Drawings or approved Shop Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

C. The HVAC Contractor or General Contractor if no HVAC Contract exists shall bring and connect HVAC service to all equipment items requiring same as shown on the Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

D. The Plumbing Contractor or General Contractor if no plumbing contract exists shall bring and connect plumbing service to all equipment items requiring same as shown on the Drawings.

1.05 SUBSTITUTIONS

A. Requests for substitutions of equipment or materials shall conform to the requirements of the General Conditions, Supplemental Conditions, and as hereinafter specified.

1. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature and performance data together with samples of the materials, where feasible, to enable the Owner and Engineer to determine if the proposed substitution is equal.

2. Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.

3. Contractor shall submit a list of installations where the proposed substitution is equal.

4. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the Owner.

B. Where the approval of a substitution requires revision or redesign of any part of the work, including that of other Contracts, all such revision and redesign, and all new drawings and details therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to the approval of the Owner and Engineer.

C. The Contractor shall provide samples and/or test specimens of the proposed substitution to the Engineer or Owner upon request.

D. In the event that the Engineer is required to provide additional engineering services, then the Engineer's charges for such additional services shall be charged to the Contractor by the Owner in accordance with the requirements of the General Conditions, and the Supplemental Conditions.

E. In all cases the Owner and Engineer shall be the judge as to whether a proposed substitution is to be approved. The Contractor shall abide by their decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the work without written approval of the Owner and Engineer.

F. Contractor shall have and make no claim for an extension of time or for damages by reason of the time taken by the Engineer in considering a substitution proposed by the Contractor or by reason of the failure of the Engineer to approve a substitution proposed by the Contractor.

G. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

1.06 QUALITY ASSURANCE

A. Contractor shall not mix piping materials, valves, or hydrants by different manufacturers without Owner's written approval. A hydrant's auxiliary valve must be by the same manufacturer as the associated hydrant.

B. Verify that rated working pressure of the item to be installed is satisfactory for the Work.

C. Marking for Identification: The name or trademark of the pipe manufacturer and the date and place of manufacture, coating, and lining shall be stenciled on all materials. Should the coating or lining be applied at another facility, the name or trademark of the applicator shall also be stenciled on the material. Pipe shall have the design working pressure and thickness or an accepted letter designation stenciled thereon. A serial number or other identification shall be used to track the pipe through the manufacturing process and shall appear on all appropriate test reports. Pipe that has been designed for abnormal load conditions shall have special markings which can be readily identified together with any special station requirements. Sections of pipe that have been gauged at the factory for field cutting shall be marked accordingly, and shall be the only pieces used where field cuts are needed.

1.07 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

A. Loading, unloading, handling, inspection, and storage of all materials shall be performed in accordance with the EDM, manufacturer recommendations, and best known practices.

B. Do not store plastic materials, piping, or fittings in direct sunlight. Provide UV protection per the manufacturer's recommendations. Support pipe to prevent sagging and bending.

C. Protect flanges, piping, fittings, seals, and specialties from moisture and dirt.

PART 2 – PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 General

A. Verify existing field conditions. Perform test pits at all known utility crossings and interconnection locations, and as required by the Contract Documents.

B. Verify that the excavation base is dry and ready to receive the Work.

C. Changes in alignment and grade shall be made by deflecting joints except where noted on the Contract Drawings.

3.02 SERVICE CONNECTIONS

A. Dig a test pit and verify the exact location, size, outside diameter, roundness, elevation, material, joint location, type, and direction of the existing main as basis of ordering material.

3.03 JOINING TO EXISTING MAIN

A. Excavate a test pit and verify the exact location, size, outside diameter, roundness, elevation, material, joint location, type, and direction of the existing main as basis of ordering material. Where fabricated steel sleeve is approved for use, make template of pipe's cross section as directed by manufacturer of sleeve.

3.04 INSTALLATION OF VALVES

A. Install valves as nearly as possible in the positions consistent with conveniences of operating the hand wheel or wrench.

B. Do not install valves with stems below the horizontal.

C. Set valves plumb and support adequately.

D. Install butterfly valves in horizontal pipes with shafts horizontal.

- END OF SECTION -

SECTION 01616S

ASSET MANAGEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Purpose

1. This Specification sets out the process by which the Offeror shall:

a. Supply information (data) in an Asset Loader Template file that is used by Owner to populate Asset records in Owner's Enterprise Asset Management (EAM) system.

2. This Specification sets out the process by which the Contractor shall:

a. Supply and install physical Asset Labels, which relate to the Asset identifiers in Owner's EAM system.

b. Produce Asset photos for use in Owner's EAM system.

c. Supply information (data) on required spare parts in Spare Parts List file and deliver Spare Parts to Owner's warehouse.

3. Note that defined term "Asset" is used throughout this Specification and is generally used interchangeably with the term "Equipment". Refer to the Definitions section for additional information.

B. Contents

1. This Specification consists of the contents herein and the following supplementary documents will be provided as part of the Expansion Project:

a. Appendix 1 – Asset Management Process. This step-by-step guide details the execution of the process outlined in this Specification from Project kickoff through design and construction. It includes responsible parties, task numbers, and task descriptions and shall serve as a checklist for use by the Contractor.

b. Appendix 2 – Asset Loader Template.

c. Appendix 3 – Spare Parts List.

d. Appendix 4 – Example Photos of Installed Asset Labels.

C. Scope

1. The Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to:

a. Provide monthly Asset characteristic information in the Asset Loader Template for all Assets installed during each month.

b. Supply and install Asset Labels throughout the Project as shown and as specified herein.

c. Produce and provide Asset photos as specified herein.

d. Provide required information in the Spare Parts List, tag all Spare Parts pursuant to the final Spare Parts List, and deliver Spare Parts to Owner.

2. Types of products required include the following:

a. Plastic Asset Labels.

b. Stainless Steel Asset Labels.

c. Lead and wire seals, two-part epoxy, and other mounting accessories.

1.02 DEFINITIONS

A. Asset: Unique Equipment items, including, but not limited to, structures, pumps, electrical and control panels, valves, flow meters, transducers, pressure indicators, blowers, compressors, spare Equipment, etc. Assets, as defined in the Contract Documents, are only those unique Equipment items listed in the Asset Loader Template, unless noted otherwise.

B. Asset Label: Includes physical Functional Location Tag (FLT), mounted adjacent to or on the permanent base of the Equipment and physical Unique Equipment Identification No. (UEI) Tag, installed on each Asset incorporated in the Work. Example FLT Asset Label: ABCD-AB-0123. Example UEI Tag Asset Label: 1000123456.

C. Asset Loader Template: This table is pre-populated with each unique Asset proposed with the Project and includes identifying and characteristic information for each Asset. A digital file (Excel format) of the table shall be provided to the Contractor by Owner within 15 days of issuance of the Notice to Proceed, which shall be used by the Contractor to populate additional required Asset characteristic information during construction.

D. Asset Record Photographs: Photos of each unique Asset in its installed position, which are uploaded to Owner's EAM system.

E. Functional Location Tag (FLT): Unique identification name, assigned by Owner, representing the Asset location and function within the facility. Functional Location Tag will always remain with the installed location and function, and will not change when the Asset is replaced.

F. Spare Equipment: Replacement Equipment, including, but not limited to pumps, blowers and flow meters. Spare Equipment, as defined in the Contract Documents, is an entire assembly that would be required for the full replacement of an Asset in the event of its failure.

G. Spare Parts: Parts and materials necessary for the repair and/or maintenance of Equipment, including, but not limited to gaskets, fuses, light bulbs, and chemicals. Spare Parts are not included in the Asset Loader Template.

H. Spare Parts List: This table is pre-populated with each unique Spare Part required by the Project Specifications. A digital file (Excel format) of the table shall be provided to the Contractor by Owner no later than the Preconstruction Conference, which shall be used by the contractor to populate additional required Spare Parts information.

I. Unique Equipment Identification (UEI) Tag: Unique identification number, assigned by Owner. Unique Equipment Identification No. (UEI) will always remain with the actual Asset, and will not change when the Asset is relocated to another location, function, or facility within Owner’s system.

1.03 COORDINATION

A. Coordinate with Owner as outlined in “Construction” section of Appendix 1 – Asset Management Process.

B. For items that will be inaccessible after installation (e.g. submersible pump that will be lowered into wet well), install Asset Labels and capture Asset photos prior to installing.

C. Coordinate types of adhesives and fasteners with mounting surfaces.

D. Generally, Functional Location Tag Asset Labels are affixed to the Asset mounting location (e.g. concrete pump pedestal) with two-part epoxy and the Unique Equipment Identification Tag Asset Labels are hung directly on the Asset (e.g. pump) with lead and wire seals. Reference example photos of Asset Label installations in Appendix 4.

E. Contractor shall coordinate with Owner if Contractor cannot determine a suitable mounting location for certain Asset Labels due to Site conditions.

1.04 QUALITY ASSURANCE

A. Asset Label Manufacturers:

1. Engage firms specializing in the production of the types of products specified, in compliance with specified standards, with a documented record of successful in-service performance, and who can provide sufficient production capacity to avoid delaying the work.

B. Component Supply and Compatibility:

1. Obtain Asset Labels from a single supplier and from a single manufacturer.

2. Asset Labels shall be plastic as specified herein in Part 2, black in color with white lettering and numbering.

1.05 SUBMITTALS

A. Samples: Submit the following:

1. Contractor shall submit two representative samples of the Functional Location Tag (FLT) Asset Labels and two representative samples of the Unique Equipment Identification (UEI) No. Asset Labels for review and approval by Owner. Samples shall be resubmitted as required until approved.

2. Owner’s review of samples will be for color and texture only. Compliance with all other requirements is the responsibility of the Contractor.

B. Other Submittal Requirements

1. All submissions of the Asset Loader Template and Spare Parts List shall be in electronic (Excel) format.

2. Submit name and experience record of manufacturers to Owner.

3. Refer to "Construction" section of Appendix 1 – Asset Management Process for details on the process and timing of Asset Label approval and installation as well as the Spare Parts List approval and Spare Parts delivery to Owner.

C. Asset Management Process: The steps in this section are intended to complement and provide additional detail on the procedures outlined in Appendix 1 – Asset Management Process.

1. Each Asset shall be provided with two Asset Labels:

   a. The Functional Location Tag Asset Label, typically mounted adjacent to the Asset or on the permanent Asset base.

   b. The Unique Equipment Identification No. Asset Label, secured to the Asset.

   c. Note that the Functional Location Tag and Unique Equipment Identification No. shall exactly match corresponding tag in Asset Loader Template.

2. Spare Equipment shall be provided with one label that shall show the Unique Equipment Identification No. (UEI). The Unique Equipment Identification No. (UEI) shall exactly match corresponding Asset data in Asset Loader Template.

3. Spare Parts shall not receive a Functional Location Tag or Unique Equipment Identification No.

4. The Contractor shall utilize the Asset Loader Template (Excel file) to document all applicable information that becomes available for each Asset during construction including but not limited to manufacturer, model, serial number, weight of object, unit of weight, size, purchase price, purchase date, date installed, and other characteristic information specific to the Asset. If additional Assets not included in the Asset Loader Template are identified to be incorporated into the Work during Construction, Contractor shall seek assistance from Owner for guidance on how to populate the spreadsheet.

5. As a prerequisite to acceptance of any Contractor Application for Payment beyond the first Application for Payment, and following Owner approval of Contractor's Schedule of Submittals and Schedule of Values, Contractor shall provide monthly an updated copy of the Asset Loader Template:

   a. For the first month's submittal of the Asset Loader Template, make a copy of the "Data" tab in the worksheet and rename it in the format "Data [month] [year]". Continue a similar process each month.

   b. Provide required Asset information for each entry (see Paragraph 4 above).

   c. For months in which no Assets are installed, include "no Assets installed" in the first row on the tab.

   d. Contractor shall not provide a cumulative Asset Loader Template in a single worksheet for the purposes of the monthly updates. Each monthly worksheet shall address only Asset Loader Template changes from the previous month.

6. Any authorized change in the Work issued by Owner shall be deemed to automatically expand the Asset Loader Template; including Asset labeling requirements, if any additional Work authorized therein results in Contractor constructing or supplying Equipment, materials, fixtures, etc. of a similar nature to any Asset previously existing in the Asset Loader Template, and such Equipment, materials, fixtures, etc. shall automatically be deemed Assets as defined in the Contract. Upon request of the Contractor, Owner shall provide Contractor guidance on how to populate the Asset Loader Template with Owner's Standard Asset Management identification attributes for additional Assets incorporated into the Work in this manner.

7. As a prerequisite to Substantial Completion, Contractor shall:

   a. Submit a completed Spare Parts List to Owner for review and approval. Upon Owner approval of completed Spare Parts List, Contractor shall organize Spare Parts at the Site and label them per the approved Spare Parts List. Contractor shall then coordinate with Owner to schedule a meeting at the Site during which Owner can review the labeled Spare Parts versus the approved Spare Parts List as preparation for delivering Spare Parts to Owner's warehouse.

   b. Contractor shall then schedule delivery of Spare Parts to Owner's warehouse in advance of the day of delivery. Contractor shall deliver Spare Parts to Owner's Warehouse on the scheduled day. Owner shall be present to review delivery per the approved Spare Parts List and provide written approval of transfer.

   c. Submit and obtain approval from Owner of the final, fully complete electronic Asset Loader Template containing all information for Assets incorporated into the Work. All Functional Location Tags (FLTs) shall be in place, either mounted adjacent to or on the permanent Equipment base of all Assets.

8. As a prerequisite to Final Completion, Contractor shall:

   a. Order and install all Unique Equipment Identification No. Tag Asset Labels. Note that within seven (7) business days of obtaining Substantial Completion, Owner will provide to Contractor a list of all Unique Equipment Identification numbers in the electronic Asset Loader Template.

   b. Produce Asset Record Photographs for each Asset contained within the Asset Loader Template. Each Asset shall be photographed in its installed position with sufficient lighting and photo resolution. A minimum of three unique photographs shall be captured for each Asset as follows:

      i. Zoomed out photo of Asset and its nearby surroundings for context.

      ii. Zoomed in photo with the single Asset in the frame. Attempt should be made to capture the FLT and UEI tags in the photo.

iii. Individual photo(s) of the nameplate(s).

c. The Asset record photo package shall include all photos in .JPG format on a CD-ROM, DVD, or USB flash drive. Each photo shall be named with the Asset Unique Equipment Identifier followed by an underscore and the series photo number followed by the format suffix (e.g. 1000233718_1.JPG, 1000233718_2.JPG; 1000233800_1.JPG, 1000233800.JPG…).

PART 2 - PRODUCTS

2.01 ASSET LABELS

A. Surface Mounted Asset Label Specifications:

1. Text: Provide the following:

a. Functional Location Tag Asset Labels shall be provided using engraved 3/8-inch high letters, corresponding exactly to the Functional Location Tag presented in the Asset Loader Template.

b. Unique Equipment Identification No. Asset Labels shall be provided using engraved 3/16-inch high letters, corresponding exactly to the Unique Equipment Identification No. presented in the Asset Loader Template.

c. Text and symbols shall be Standard Helvetica Medium, all upper case, and centered on Asset Label.

2. Size and Material: Provide the following:

a. Functional Location Tag shall be 1-inch in height by 4-inches in width, minimum. Material shall be Johnson Plastics Rowmark plastic or equal for use in the proper environment (high temperature, corrosive, abrasive, and/or habitable).

b. Unique Equipment Identification No. shall be 1.5-inches in diameter, minimum. Material shall be 304 stainless steel or Johnson Plastics Rowmark plastic for use in the proper environment (high temperature, corrosive, abrasive, and/or habitable).

c. Products and Manufacturers: For plastic Asset Labels: Johnson Plastics Rowmark Satins Black/White 1/16-inch Thick Engraving Plastic or equal.

3. Miscellaneous Surface Mounted Asset Label Accessories:

a. Two-Part Epoxy:

i. Affix all surface mounted Asset Labels with LOCTITE EA E-OOCL Hysol two-part epoxy (part number 29289) or equal.

b. Mechanical Label Anchoring:

i. Where two-part epoxy cannot be used, surface mounted Asset Labels may be mechanically anchored to Assets, or specialized concrete bases, where permitted by Owner.

ii. Fasteners: Provide fasteners of non-magnetic stainless steel of size and type required and recommended by individual identification device manufacturers.

iii. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts. Use toothed stainless steel or lead expansion bolts for drilled-in-place anchors.

B. Hanging Asset Label Specifications:

1. Provide hanging Asset Labels for all Assets not featuring a flat surface or close adjacent surface suitable for mounting Asset Labels. Assets suitable for hanging Asset Labels may include valves, pumps, instrumentation devices, etc.

2. Text: Provide the following:

a. Provide as specified in Paragraph 2.01-A.1 herein.

3. Size and Material: Provide the following:

a. Provide as specified in Paragraph 2.01-A.2 herein.

4. Miscellaneous Round Hanging Asset Label Accessories:

a. Stainless Steel Wire: Nylon coated; outside diameter 0.048-inches.

b. Clamps: Brass.

c. Lead Seals: Monel; Four ply, 0.014-inches by 10-inches long; for attaching all tags.

d. Hand Sealing Press: As recommended by tag manufacturer for crimping lead seals.

e. No. 16 stainless steel jack chain may be used in lieu of above referenced attachment methods.

PART 3 EXECUTION

3.01 INSPECTION

A. Contractor and his installer shall examine the substrates and conditions under which the Asset Labels are to be installed and notify Owner, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Owner.

3.02 INSTALLATION

A. Asset Labels:

1. Locate Asset Labels on Assets, or on structures at readily visible levels in such positions relative to the Asset and structures as to prevent damage to the Asset Label, where specification allows.

2. Install level and plumb.

3.03 PROTECTION AND CLEANING

A. After installation, clean soiled Asset Label surfaces according to manufacturer’s instructions.

B. Protect Assets and Asset Labels from damage until Final Completion.

END OF SECTION

SECTION 01652S

PROJECT COMMISSIONING

PART 1 -- GENERAL

1.01 GENERAL REQUIREMENTS

A. This Section describes Project Commissioning for process mechanical equipment and process control hardware that occurs between installation and Substantial Completion. The three major phases of Project Commissioning include Pre-Commissioning, Testing, and Startup. Attachments A, B, and C are included to depict the overall sequence of the Project Commissioning process. Neither this Specification section nor the included attachments are intended to be an all-inclusive representation of the Work required for Substantial Completion of this Project.

B. Definitions and constraints for Project Commissioning activities are described herein to facilitate the Offeror's performance of the Work.

1.02 DEFINITIONS

1. Component – Individual piece of Process Mechanical Equipment.

2. Enterprise Visualization System Supplier (EVSS) – Entity responsible for verification of all Owner SCADA functionality associated with Project Commissioning. Unless stated otherwise in the Specifications, this role is performed by the Owner.

3. Human Machine Interface (HMI) – The centralized SCADA interface that connects multiple Project subsystems with a single graphical interface. The HMI collects data, manages alarms, provides historical trends, and creates analytical reports for Owner control of Project Facilities.

4. Heavy Construction – Construction of the Work from Notice to Proceed to the start of Project Commissioning.

5. Process Control Hardware – Instrumentation and control hardware installed under the Project for monitoring and control of the new Process Mechanical Equipment. Examples of instrumentation are level sensors, pressure sensors, limit switches, etc. Examples of control hardware include OITs, PLCs, etc.

6. Process Mechanical Equipment – Switchgear and motor control centers (electrical gear) and mechanical components that collectively enable the Project to deliver the intended process capacity.

7. Project Facilities – Process Mechanical Equipment and Process Control Hardware.

8. Operator Interface Terminal (OIT) – Device typically connected to the PLC that allows local control of automated systems. This device can visually display information from

Process Mechanical Equipment such as alarms, live date, and historical trends.

9. Process Control System Supplier (PCSS) – Entity responsible for verification of all control strategies associated with Project Commissioning. The PCSS is also known as the System Integrator for the Project.

10. Programmable Logic Controller (PLC) – Industrial computer that provides centralized control of all new process signals associated with the Project.

11. Subsystem – Project Facility that can be commissioning in a standalone fashion and declared Substantially Complete as a portion of the Work.

12. Supervisory Control and Date Acquisition (SCADA) – The Owner's communication network for the remote control and monitoring of Project Facilities which is interfaced at the HMI for Project Facilities.

13. System – All Project Facilities. Also known as the project.

1.03 SUBMITTALS

C. Submittals discussed in this Specification Section include:

1. Factory Acceptance Testing Plan
2. Factory Acceptance Testing Test Report
3. Testing/Equipment Startup Plan
4. Protective Device Settings
5. Manufacturers Certificates of Calibration
6. Manufacturers Certificates of Proper Installation
7. Operational Readiness Testing 1 Checklist
8. Operational Readiness Testing 2 Checklist
9. PLC and OIT source code
10. Operational Readiness Testing 3 Checklist
11. Training Lesson Plans
12. O&M Manuals
13. Operational Readiness Testing 4 Checklist
14. Preliminary Functional Demonstration Testing Checklist
15. Final Functional Demonstration Testing Checklist

16. Biological System Startup Plan

17. Biological System Startup Report

18. Performance Acceptance Testing Plan

19. Performance Acceptance Testing Report

1.04 PRE-COMMISSIONING

A. Pre-Commissioning refers to the checkout of project facilities before the Testing portion of the commissioning commences as described herein and illustrated by Attachment A.

B. Factory Acceptance Test (FAT) – This activity occurs during heavy construction and is an opportunity for the Engineer and/or Owner to witness the functionality of process control hardware before shipment to the site. FATs typically occur at the manufacturer's shop where the equipment was assembled. The FAT Plan includes a checklist to verify each component's functionality for process control hardware as approved by the Engineer/Owner and fabricated by the supplier. During the FAT, the Engineer/Owner sign off on the functionality of each component upon successful demonstration thereof. Completed checklist(s) are formally submitted by the Offeror for information only upon conclusion of the FAT along with the FAT test report.

   1. Factory Acceptance Test (FAT) Plan – This submittal describes the testing procedures for the FAT (as required in Division 13S, 15S and/or 16S Specifications) including all checklists for Engineer/Owner witnessing. An approved FAT Plan is a prerequisite for scheduling the FAT. The Engineer/Owner will determine its level of participation during the FAT upon approval of the FAT Plan submittal.

   2. FAT Test Report – This submittal includes the completed FAT checklists. A completed and approved FAT test report is a prerequisite for the shipment of process control hardware to the project site for installation.

C. Equipment Installation – This activity refers to the installation of project facilities at the project site. The Offeror shall formally submit the Protective Device Settings as required below:

   1. Protective Device Settings – The Offeror shall provide the electrical settings (such as breaker trip settings) for electrical gear that are intended to protect downstream process mechanical equipment from damage due to electrical faults and other hazards. The approval and implementation of these settings is a prerequisite to energizing any equipment.

D. Equipment Energize/Certificate of Proper Installation (COPI) – For this activity, the Offeror shall provide a certification from each manufacturer that the process mechanical equipment has been properly installed by the Contractor. Equipment is energized for the first time in a manual mode by the manufacturer during this process. The following submittals are required prior to any Ready for Testing Determination:

1. Approved Testing/Equipment Startup Plan – The Offeror is required to provide this submittal as the overall plan for testing and startup of new process mechanical equipment including all components, subsystems, and system. This submittal shall include detailed procedures that adhere to the testing and startup activities found in this Specification, and dates and timelines for the various testing and startup activities. Additionally, the Offeror shall include all the necessary checklists for Engineer/Owner witnessing of the various testing and startup activities as described herein. The checklists shall be prepared using the guidance of the Sequence of Operation and Functional Control Descriptions Specifications. Submission and approval of the Testing/Equipment Startup Plan submittal is a prerequisite for the commencement of Testing as described herein and illustrated by Attachment B. **Note:** The Testing/Equipment Startup Plan includes Preliminary Functional Demonstration Testing and Final Functional Demonstration Testing. It is not intended to include the Training Lesson Plans, the Biological Startup Plan, or the Performance Acceptance Test Plan. These items should be provided by the Offeror as separate submittals.

2. Certificates of Calibration – The Offeror shall provide an onsite certification by each instrumentation supplier that their instruments have been properly calibrated. Instrumentation is energized for the first time by the manufacturer during this certification process. The manufacturer's signed certificates of calibration shall be submitted by the Offeror for approval as a prerequisite to testing.

3. Approved COPIs – The Offeror's submission and the Engineer/Owner's approval of all signed manufacturer's COPIs is a prerequisite for testing.

4. Ready for Testing Determination – When the Offeror has completed all activities and prerequisites associated with Pre-Commissioning, the Offeror shall formally request permission to begin Testing as described herein. If, in the opinion of the Engineer/Owner, all Pre-Commissioning activities and prerequisites are complete, the Owner will issue to the Offeror in writing a "Ready to Test Determination".

1.05 TESTING

A. Operational Readiness Testing (ORT) 1 – Upon receipt of the Owner's "Ready for Testing Determination", the Offeror may commence ORT 1. ORT 1 is a Offeror-initiated activity that is conducted with the support of the Offeror's PCSS/System Integrator. The purpose of ORT 1 is to confirm the proper setup, configuration, and calibration of project facilities. All test signals required for ORT 1 shall be generated by a Offeror-provided signal generator. **Note:** No PLC shall be used to generate test signals during ORT 1. The Offeror shall provide all necessary equipment to receive and detect test signals at field devices. The Offeror shall document ORT 1 on the designated checklist from the approved Testing/Equipment Startup Plan submittal.

1. Completed ORT 1 Checklist - The successful completion of ORT 1 in its entirety, and submission and approval of the completed ORT 1 checklist is a prerequisite for the commencement of ORT 2.

B. Operational Readiness Testing (ORT) 2 – Upon submission of the Offeror's completed ORT 1 checklist, the Offeror may schedule ORT 2 with the Engineer and Owner. ORT 2 is a Offeror-initiated activity that is conducted with the support of the Offeror's PCSS/System Integrator. The purpose of ORT 2 is to confirm the proper installation and termination of all control wiring from its terminus (control panel, remote I/O, etc.) to each field device. All test signals required for ORT 2 shall be generated by the installed field devices whenever possible. Otherwise, a Offeror-provided signal generator shall be used. A simulated PLC program provided by the PCSS may be used to generate PLC output signals. The Offeror shall provide all necessary equipment to receive and detect test signals at field devices. The Offeror shall document ORT 2 on the designated checklist from the approved Testing/Equipment Startup Plan submittal.

1. Completed and Owner Witnessed ORT 2 Checklist - The successful completion of ORT 2 in its entirety and submission and approval of the completed ORT-2 checklist is a prerequisite to the commencement of ORT 3.

2. Upload PLC Program – For projects that include PLC automation, this prerequisite is a requirement for the commencement of ORT 3. If the PLC program is a Contract requirement, then the Offeror is required to complete this task. If the PLC program is Owner furnished, then the Owner is required to complete this task.

C. Operational Readiness Testing (ORT) 3 – Upon submission of the Offeror's completed ORT 2 checklist and successful upload of the PLC source code, the Offeror may schedule ORT 3 with the Engineer and Owner. ORT 3 is a Offeror-initiated and Engineer/Owner-witnessed activity that is conducted with the support of the Offeror's PCSS/System Integrator. The EVSS or Owner (when applicable) will perform the verification at the Owner's SCADA system. The purpose of ORT 3 is to allow the Engineer and Owner to verify that the programmed PLC is properly sending and receiving inputs and outputs from field devices via the installed HMI and OITs. All test signals required for ORT 3 shall be generated by the PLC, unless a written waiver is submitted to allow the use of a Offeror-provided signal generator. The Offeror shall provide all necessary equipment to receive and detect test signals at field devices as necessary. The Offeror shall document ORT 3 on the designated checklist from the approved Testing/Equipment Startup Plan submittal.

1. Provide PLC and OIT Source Code – The Offeror shall provide to the Owner any Offeror furnished PLC and OIT source code as a prerequisite to the commencement of ORT 4.

2. Completed and Owner Witnessed ORT 3 Checklist - The successful completion of ORT 3 in its entirety and submission and approval of the completed ORT-3 checklist is a prerequisite to the commencement of ORT 4.

D. Operational Readiness Testing (ORT) 4 – Upon submission of the Offeror's completed ORT 3 checklist and the turnover of all Offeror PLC and OIT source code, the Offeror may schedule ORT 4 with the Engineer and Owner. ORT 4 is a Offeror-initiated and Engineer/Owner-witnessed activity that is conducted with the support of the EVSS or Owner (when applicable). The purpose of ORT 4 is to allow the Engineer and Owner to verify through the Owner's SCADA System that all control strategies have been properly implemented, and that alarms are properly generated by the PLC, received through the Owner's SCADA system, and properly acted upon. All test signals required for ORT 4 shall be generated by the PLC, unless a written waiver is submitted to allow the use of a Offeror-provided signal generator. The Owner shall provide the personnel necessary to verify alarms at locations that are remote to the Project. The Offeror shall document ORT 4 on the designated checklist from the approved Testing/Equipment Startup Plan submittal.

1. Approved Training Lesson Plans – As a prerequisite to Startup, the Offeror shall submit and receive an approved status on all training lesson plan submittals.

2. Approved Preliminary O&M Manuals – As a prerequisite to Startup, the Offeror is required to achieve an approved status on all preliminary O&M manual submittals.

3. Completed and Owner Witnessed ORT 4 Checklist - The successful completion of ORT 4 in its entirety and approval of the completed ORT 4 checklist is a prerequisite to the commencement of Startup.

4. Ready for Startup Determination - When the Offeror has completed all Testing activities, the Offeror shall formally request permission to begin Startup as described herein and as illustrated by Attachment C. If in the opinion of the Engineer/Owner, all Testing activities and prerequisites are complete, the Owner will issue to the Offeror in writing a "Ready for Startup Determination".

5. Biological System Startup Plan – This plan is for the startup of the Sidestream Deammonification Biological System. Submission and approval of the Biological System Startup Plan submittal is a prerequisite for the commencement of Biological System Startup as described herein. This plan shall be prepared by the Offeror and accepted by Loudoun Water and the Engineer at least 30 days prior to the start of Biological System Startup. This submittal shall include the following:

    a. Detailed description of the types of activities to be performed during the Biological System Startup, including, but not limited to, the following Startup Activities:

    b. Sequence of Events during biological system startup and timeline.

c. Process Monitoring during biological system startup (tank levels and temperature values, process water and air flow rates, pH, and NH4-N values, etc.).

d. Grab Sampling and Analyses to be performed during biological system startup.

e. Anticipated Biological System Startup Schedule with Task Description and expected level of personnel support required.

f. Biological System Startup troubleshooting guidelines.

g. Meeting schedule.

h. All the necessary checklists for the Engineer/Owner witnessing of the various performance parameters required by the Specifications

1.06 STARTUP

A. Preliminary Functional Demonstration Testing (P-FDT) – Upon receipt of the Owner's "Ready for Startup Determination," the Offeror may commence P-FDT. P-FDT is an activity where project facilities are run for a pre-determined duration for the first time in an automated mode. All testing is with inert (non-process) fluids where applicable. Process fluids shall not be used for P-FDT unless approved in writing by the Engineer/Owner. P-FDT will begin at the component level where process control equipment is tested individually for one hour in a fully automated mode. Upon successful completion of component level testing, the Offeror shall submit the appropriate completed checklists from the approved Testing/Equipment Startup Plan. Approval of all component checklists by the Engineer/Owner is a prerequisite to the start of P-FDT at the subsystem level (where applicable). Each subsystem shall be tested in a fully automated mode for 4 hours. Upon successful completion of subsystem level testing, the Offeror shall submit the appropriate completed checklists from the approved Testing/Equipment Startup Plan. Approval of all subsystem checklists by the Engineer/Owner is a prerequisite to the start of P-FDT at the System (project) level. The System shall be tested in a fully automated mode for 24 hours. Upon successful completion of System level testing, the Offeror shall submit the appropriate completed checklist from the approved Testing/Equipment Startup Plan.

1. Completed P-FDT Checklists for Components, Subsystems & System - The successful completion of P-FDT in its entirety as evidenced by submission and approval of all completed P-FDT checklist is a prerequisite to the commencement of F-FDT.

B. Final Functional Demonstration Testing (F-FDT) – Upon approval of the Offeror's P-FDT checklists, the Offeror may commence F-FDT. F-FDT is an activity where project facilities are run for a pre-determined duration in an automated mode with process fluids. For components and subsystems where process fluids were necessary to perform P-FDT, successful P-FDT test results shall constitute successful F-FDT for those components and subsystems. F-FDT will begin at the component level where process mechanical equipment is tested individually for 2 hours in a fully automated mode. Upon successful completion of component level testing, the Offeror shall submit the appropriate completed checklists from the approved Testing/Equipment Startup Plan. Approval of all component checklists by the Engineer/Owner is a prerequisite to the start of F-FDT at the subsystem level (where applicable). Each subsystem shall be tested in a fully automated mode for 8 hours. Upon successful completion of subsystem level testing, the Offeror shall submit the appropriate completed checklists from the approved Testing/Equipment Startup Plan. Approval of all subsystem checklists by the Engineer/Owner is a prerequisite to the start of F-FDT at the System (Project) level. The System shall be tested in a fully automated mode for 48 hours. Upon successful completion of System level testing, the Offeror shall submit the appropriate completed checklist from the approved Testing/Equipment Startup Plan.

1. Completed F-FDT Checklists for Components, Subsystems & System - The successful completion of F-FDT in its entirety as evidenced by submission and approval of all completed F-FDT checklists is a prerequisite to the commencement of Biological System Startup.

C. Biological System Startup – Upon completion of F-FDT, the next activity is Biological System Startup. This phase involves the introduction of biological seed sludge and proliferation of the sludge in the new Sidestream Deammonification Reactor. Biological System Startup shall be performed as recommended by the Offeror and as specified in Section 11200S. The Offeror shall coordinate all services and activities required by this Section with the Offeror, the Engineer, and Loudoun Water. Biological System Startup shall be completed by the Offeror within the allocated time as identified in the Agreement. Failure to complete the Biological System Startup as required by this Section within the allocated time identified in the response to the RFP shall constitute a failure of the Offeror to provide Services in accordance with the requirements of the Contract. The Offeror shall be assessed Liquidated Damages in accordance with Section 5 of the RFP.

1. Biological System Startup Report – This report is to detail the results of the Biological System Startup (including a copy of all field notes and test data) once the biological system has achieved steady state operation during its startup period. This report should contain, but is not limited to, the following items:

   a. A background of the project and biological system start-up timeline.

   b. A summary of the sequence of steps for biological system start-up.

   c. Performance data and measurement methods.

   d. Meeting schedule

2. Performance Acceptance Testing Plan – This plan is for verifying the offeror guaranteed performance of the project. This submittal shall include the method, dates and timelines that the Offeror will use to verify performance guarantees. Additionally, this submittal shall include all the necessary checklists for the Engineer/Owner witnessing of the various performance parameters required by the Specifications. The checklists shall be prepared to conform the Performance Acceptance Testing section in Specification 11200. Submission and approval of the Performance Acceptance Testing Plan submittal is a prerequisite for the commencement of Performance Acceptance Testing as described herein. This plan shall be prepared by the Offeror and accepted by Loudoun Water and the Engineer at least 30 days prior to the start of PAT.

3. Notice of Completed Biological System Startup – When the Offeror has completed all Biological Startup activities, the Offeror shall formally request permission to begin the Performance Acceptance Test as described in Section 11200S and as Illustrated by Attachment C. If in the opinion of the Engineer/Owner, all Biological Startup requirements are complete, the Owner will issue to the Offeror in writing a "Notice of Completed Biological System Startup". The "Notice of Completed Biological System Startup" is a prerequisite to the commencement of PAT.

D. Performance Acceptance Testing (PAT) – Upon completion of the Biological System Startup and the issuance of the "Notice of Completed Biological System Startup", the next activity is PAT, which is intended to confirm that the Sidestream Deammonification System is in compliance with the performance guarantee, service conditions, performance requirements, material specifications, and all other requirements of the Procurement Documents. This test will verify that the new facilities collectively included in the project are able to achieve the performance which they were installed and commissioned. PAT shall be witnessed by the Engineer/Owner, and it shall be documented on forms previously approved for use by the Engineer/Owner. Performance Acceptance Testing shall be performed as specified in Section 11200S. PAT shall be commenced within seven (7) days of completion of Biological System Startup; and at a mutually agreed upon time by the Offeror, Loudoun Water, Offeror, and Engineer. To begin the PAT after the 7-day period, a formal request must be issued and also mutually agreed upon by the Offeror, Loudoun Water, Contractor, and Engineer. PAT shall be completed by the Offeror within the allocated time identified in coordination with the Contractor selected for the Expansion Project. Failure to complete the PAT within the allocated time shall constitute a failure of the Offeror to provide Services in accordance with the requirements of the Contract. The Offeror shall be assessed Liquidated Damages in accordance with Section 5 of the RFP until PAT is complete. Upon successful completion of PAT by the Offeror, including Engineer/Owner acceptance and approval of the test results, the Offeror may proceed with Reliability Demonstration Testing as necessary.

1. PAT Report – The Offeror shall submit to Loudoun Water a written and electronic report detailing the results of the PAT (including all field notes and test data). This Report should include, but is not limited to:

a. A background of the project and PAT timeline.

b. A summary on the sequence of steps for PAT.

c. Performance data and measurement methods.

d. Summary of any physical or control modification made to meet the PAT.

e. Results of PAT.

E. Reliability Demonstration Testing (RDT) – Upon approval of the PAT results the Contractor may proceed with RDT. RDT is the final Project Commissioning activity before Substantial Completion. This test confirms the reliability of the completed project facilities as they function in a fully automated mode for a prescribed period of time. This test will verify whether the new facilities included in the Project are ready for transfer of ownership from the Contractor to the Owner upon achievement of Substantial Completion. Successful completion of RDT includes trouble-free 24/7 operation of the new project facilities for fourteen consecutive days while operated by the Owner. The Offeror is responsible for assisting the Owner with the resolution of all alarms encountered during RDT. Upon successful completion of RDT by the Offeror, the intent is for the Owner to take ownership of the project (via either Partial Utilization or Substantial Completion) provided that all contract requirements have been satisfied by the Offeror. **Note:** While the Owner may have "operated" the new facilities during RDT, the Offeror is ultimately responsible for the ongoing operation of the facilities until the Owner declares Partial Utilization or Substantial Completion. This includes all general maintenance of the facilities (lubrication, cleaning, repairs, etc.).

F. Equipment Training - The Offeror shall provide two separate session of training classes with the Owner. The first shall occur prior to Biological System Startup and the second shall occur prior to RDT. The Offeror is responsible for developing a training schedule that is suitable to Loudoun Water's Operations and Maintenance staff and complies with the Contract Documents. Each lesson plan shall be coordinated with the respective preliminary O&M Manual for each component where training is required. The schedule is limited to a maximum of 3 training topics per week, and 1 training topic (component) per day. Additionally, training shall not occur on the same day that equipment vendors perform testing and issue the COPI/MCPI for their respective equipment. Each day of training shall include two identical 4-hour sessions to start at times consistent with the Owner's availability of O&M staff. Training sessions may also be split so that they include 4-hour sessions on consecutive days. Equipment Training shall include both classroom (theoretical) instruction and field (hands-on) instruction and is intended to cover both operations and maintenance of new equipment. Equipment training topics shall address safety, maintenance, troubleshooting, emergency, startup, and shutdown procedures, in addition to all intended manners and modes of process operation. Equipment training is an activity that shall be completed in its entirety before Substantial Completion.

1. Spare Parts Transfer and Completed Asset Loader Template - The Offeror shall comply with the requirements set forth in Specification 01616S and Specification 11000S.

2. Approved Final O&M Manuals – As a prerequisite to Substantial Completion, the Offeror is required to achieve an approved status on all Final O&M manual submittals, including all supplemental information from Project Commissioning.

3. Successful RDT Test Results - The successful completion of RDT in its entirety as evidenced by the Owner's written approval thereof is a prerequisite to Substantial Completion.

4. Notice of Completed Commissioning – Upon successful completion of RDT, pursuant to the successful completion of all prior Startup Activities described in this Section, the Engineer shall issue the "Notice of Completed Commissioning".

5. Complete All Remaining Substantial Completion Requirements – Project Commissioning represents a portion of the Work included in this project, while Substantial Completion as defined in the General Conditions is a project activity representing the entirety of the Work. Therefore, the successful completion of Project Commissioning is a prerequisite to Substantial Completion, but it does not equate to Substantial Completion.

G. Substantial Completion – (Owner Acceptance) – As defined in the General Conditions and Specification 01700S.

PART 2 - PRODUCTS

(NOT USED)

PART 3 – EXECUTION

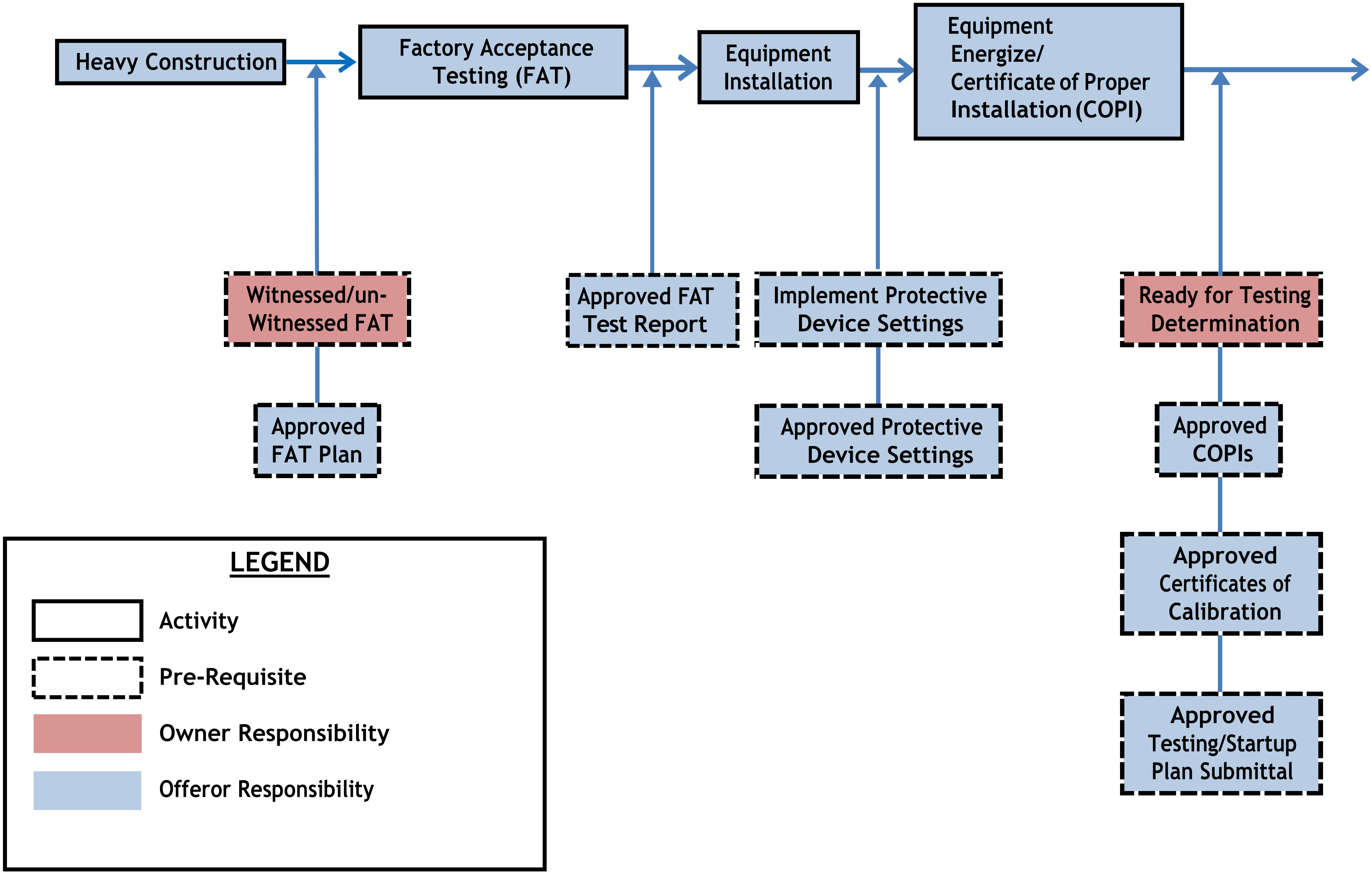
3.01 PROJECT COMMISSIONING SCHEMATICS

The attached schematic diagrams are intended to sequentially illustrate the Project Commissioning process in accordance with the three phases listed below. The attachments include the major activities and prerequisites associated with Project Commissioning and are offered as a visual "roadmap" for the Offeror, Engineer, and Owner's use during construction. The attachments are not intended to illustrate all requirements for Project Commissioning or Substantial Completion.

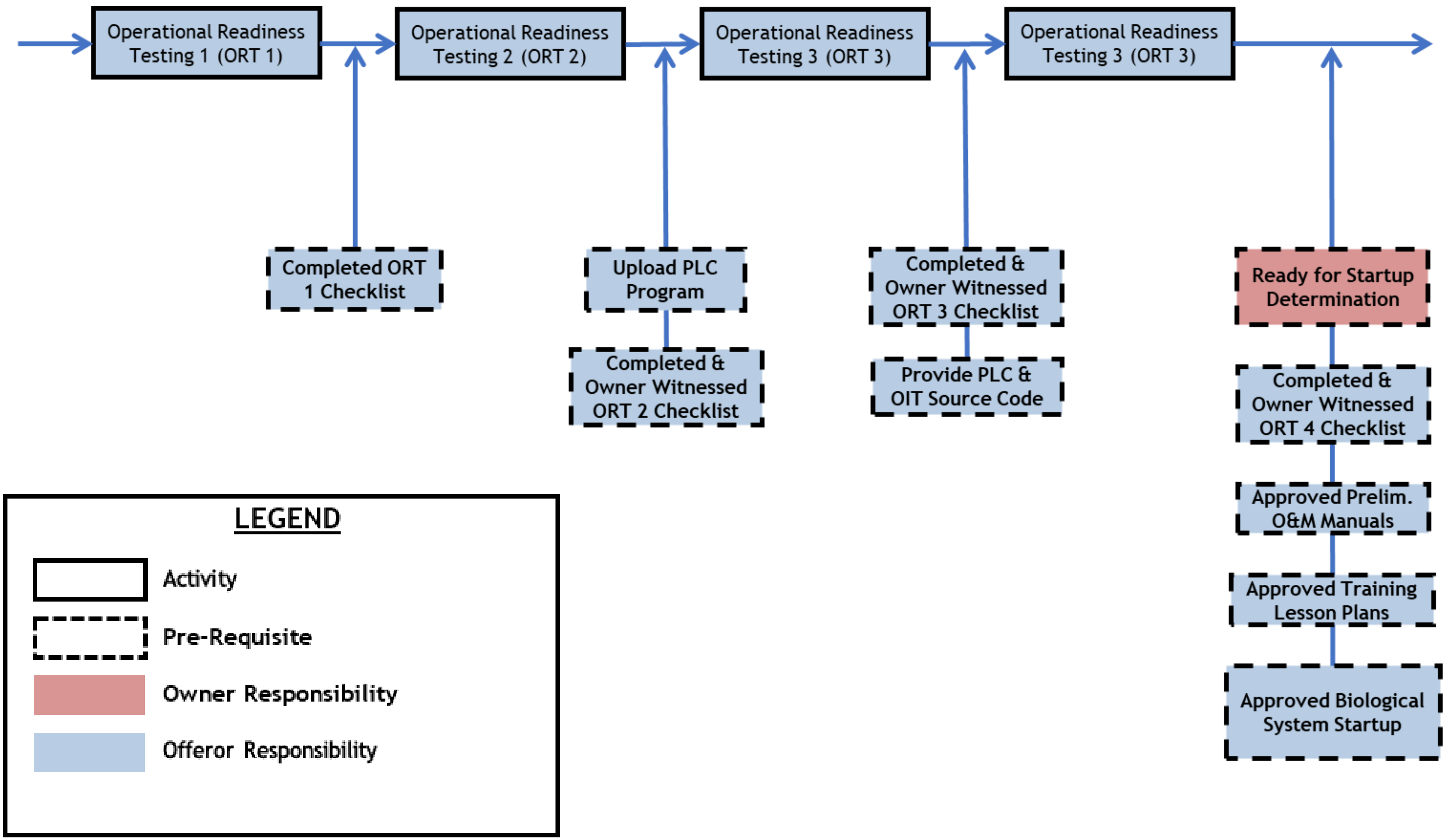
A. ATTACHMENT A – PRE-COMMISSIONING (ATTACHED)
B. ATTACHMENT B – TESTING (ATTACHED)
C. ATTACHMENT C – STARTUP (ATTACHED)

- END OF SECTION -

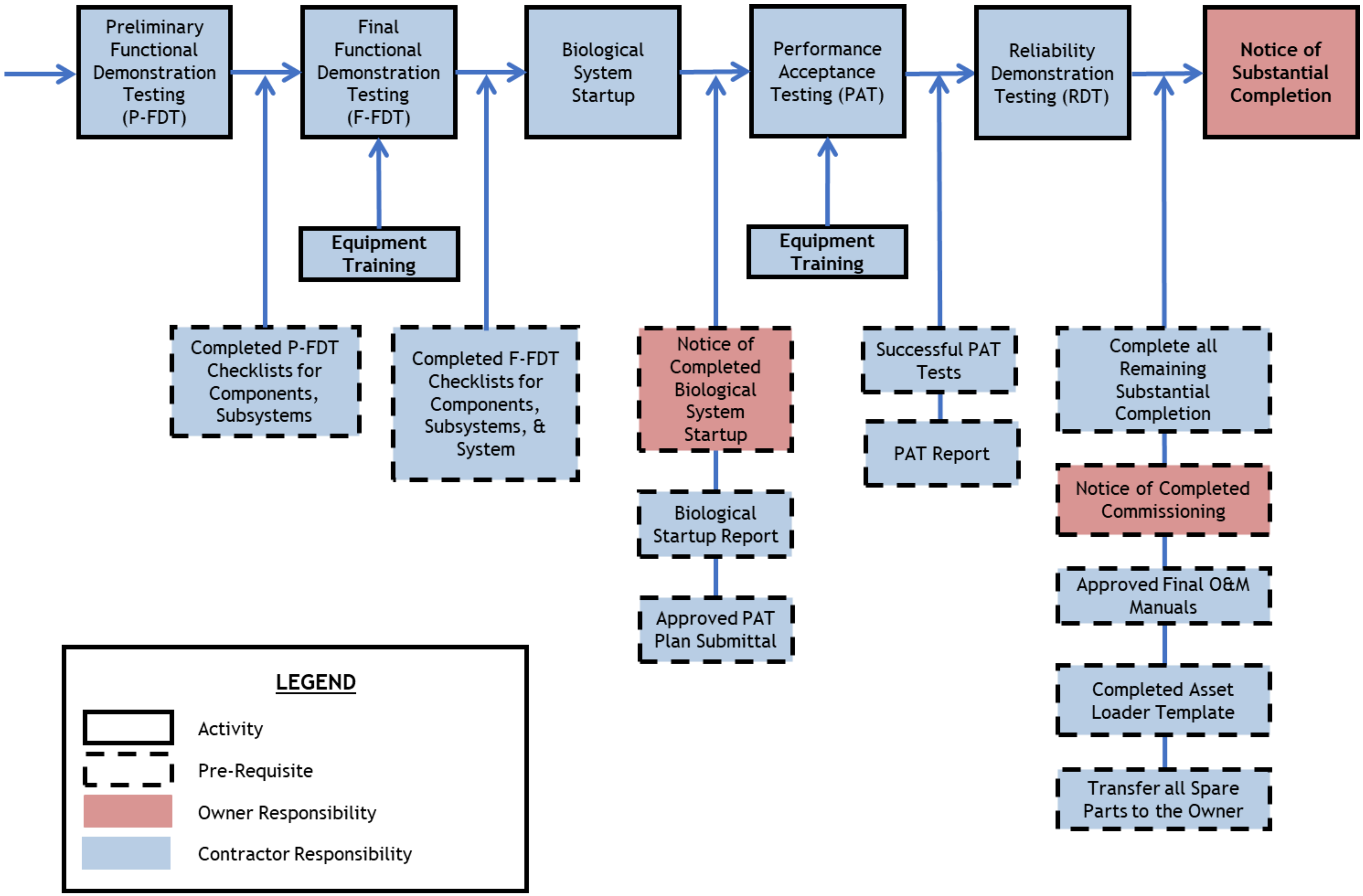
Specification Section 01652S - Project Commissioning: Attachment A - **PRE-COMMISSIONING**



Specification Section 01652S - Project Commissioning: Attachment B – **TESTING**



Specification Section 01652S - Project Commissioning: Attachment C – **STARTUP**



SECTION 05010S

METAL MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Materials for fasteners are included in Section 05050S, Metal Fastening.

B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A.	ASTM A36	Standard Specification for Structural Steel
B.	ASTM A47	Standard Specification for Malleable Iron Castings
C.	ASTM A48	Standard Specification for Gray Iron Castings
D.	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
E.	ASTM A167	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
F.	ASTM A276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
G.	ASTM A307	Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
H.	ASTM A446	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality
I.	ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
J.	ASTM A501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
K.	ASTM A529	Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)
L.	ASTM A536	Standard Specification for Ductile Iron Castings

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M.	ASTM A570	Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
N.	ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
O.	ASTM A992	Standard Specification for Structural Steel Shapes
P.	ASTM A666	Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications
Q.	ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
R.	ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings
S.	ASTM B85	Standard Specification for Aluminum-Alloy Die Castings
T.	ASTM B108	Standard Specification for Aluminum-Alloy Permanent Mold Castings
U.	ASTM B138	Standard Specification for Manganese Bronze Rod, Bar, and Shapes
V.	ASTM B209	Standard Specification for Aluminum-Alloy Sheet and Plate
W.	ASTM B221	Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
X.	ASTM B308	Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded
Y.	ASTM B574	Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod
Z.	ASTM F468	Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
a.	ASTM F593	Standard Specification for Stainless Steel Fasteners

1.04 SUBMITTALS

A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 -- PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

A. Material types and ASTM designations shall be as listed below:

1.	Steel W Shapes	A992
2.	Steel HP Shapes	A572 Grade 50
3.	Steel M, S, C,and MC shapes and Angles, Bars, and Plates	A36
4.	Rods	F 1554 Grade 36
5.	Pipe - Structural Use	A53 Grade B
6.	Hollow Structural Sections	A500 Grade C or A1085
7.	Cold-Formed Steel Framing	A 653

2.02 STAINLESS STEEL

A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.

B. Material types and ASTM designations are listed below:

1.	Plates and Sheets	ASTM A167 or A666 Grade A
2.	Structural Shapes	ASTM A276
3.	Fasteners (Bolts, etc.)	ASTM F593

2.03 ALUMINUM

A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

1.	Structural Shapes	ASTM B308
2.	Castings	ASTM B26, B85, or B108
3.	Extruded Bars	ASTM B221 - Alloy 6061
4.	Extruded Rods, Shapes and Tubes	ASTM B221 - Alloy 6063
5.	Plates	ASTM B209 - Alloy 6061
6.	Sheets	ASTM B221 - Alloy 3003

C. All aluminum structural members shall conform to the requirements of Section 05140S, Structural Aluminum.

D. All aluminum shall be provided with mill finish unless otherwise noted.

E. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.

F. Aluminum in contact with dissimilar materials shall be insulated with an approved dielectric.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

1.	Gray	ASTM A48 Class 30B
2.	Malleable	ASTM A47
3.	Ductile	ASTM A536 Grade 60-40-18

2.05 BRONZE

A. Material types and ASTM designations are listed below:

1.	Rods, Bars and Sheets	ASTM B138 - Alloy B Soft

2.06 HASTELLOY

A. All Hastelloy shall be Alloy C-276.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 05050S

METAL FASTENING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010S – Metal Materials

B. Section 05061S – Stainless Steel

C. Section 05120S – Structural Steel

D. Section 05140S - Structural Aluminum

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1.	Virginia Uniform Statewide Building Code	
2.	AC 193	Acceptance Criteria for Mechanical Anchors in Concrete Elements
3.	AC 308	Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
4.	ACI 318	Building Code Requirements for Structural Concrete
5.	ACI 355.2	Qualifications of Post-Installed Mechanical Anchors in Concrete
6.	ACI 355.4	Qualifications of Post-Installed Adhesive Anchors in Concrete
7.	AISC 348	The 2009 RCSC Specification for Structural Joints
8.	AISC	Code of Standard Practice
9.	AWS D1.1	Structural Welding Code - Steel

10.	AWS D1.2	Structural Welding Code - Aluminum
11.	AWS D1.6	Structural Welding Code – Stainless Steel
12.	Aluminum Association	Specifications for Aluminum Structures
13.	ASTM A572/A572M-94C	Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
14.	ASTM A36	Standard Specification for Carbon Structural Steel
15.	ASTM A325	Standard Specification for High-Strength Bolts for Structural Steel Joints
16.	ASTM A489	Standard Specification for Eyebolts
17.	ASTM A490	Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
18.	ASTM A563	Standard Specifications for Carbon and Alloy Steel Nuts
19.	ASTM D1785	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
20.	ASTM E488	Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
21.	ASTM F436	Standard Specification for Hardened Steel Washers
22.	ASTM F467	Standard Specification for Nonferrous Nuts for General Use
23.	ASTM F593	Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
24.	ASTM F594	Standard Specification for Stainless Steel Nuts
25.	ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01302S, Submittals.

1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.

2. Anchor design calculations sealed by a Professional Engineer currently registered in the Commonwealth of Virginia. Only required if design not shown on Contract Drawings.

3. Manufacturer's installation instructions.

4. Copy of valid certification for each person who is to perform field welding.

5. Certified weld inspection reports, when required.

6. Welding procedures.

7. Installer qualifications.

8. Certification of Installer Training.

9. Inspection Reports.

10. Results of Anchor Proof Testing.

1.05 QUALITY ASSURANCE

A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.

B. Installer Qualifications: All concrete anchors shall be installed by an Installer with at least three years of experience performing similar installations. Concrete adhesive anchor installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Installer Training: For concrete adhesive anchors, conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process to include but not be limited to the following:

1. Hole drilling procedure.

2. Hole preparation and cleaning technique.

3. Adhesive injection technique and dispenser training/maintenance.

4. Concrete adhesive anchor preparation and installation.

5. Proof loading/torquing.

D. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.

E. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.

F. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.

G. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.

H. Inspections of the adhesive dowel system shall be made by the Engineer or other representatives of the Owner in accordance with the requirements of the ESR published by the manufacturer. Provide adequate time and access for inspections of products and anchor holes prior to injections, installation, and proof testing."

PART 2 -- PRODUCTS

2.01 ANCHOR RODS (ANCHOR BOLTS)

A. Anchor rods shall conform to ASTM F1554 Grade 36 except where stainless steel or other approved anchor rods are shown on the Drawings. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.

B. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot-dip galvanized in accordance with ASTM F1554.

C. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.02 HIGH STRENGTH BOLTS

A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC 348 "The 2009 RCSC Specification for Structural Joints".

B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS

A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

2.04 CONCRETE ANCHORS

A. General

1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by an approved independent testing laboratory. There are two types used:

a. Expansion anchors shall be mechanical anchors of the wedge, sleeve, drop-in or undercut type.

b. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.

2. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.

3. Unless otherwise noted, all concrete anchors which are submerged or are used in hanging items or have direct tension induced upon them, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.

4. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Expansion or mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193.

5. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or anchor non-structural elements.

6. Engineer's approval is required for use of concrete anchors in locations other than those shown on the Drawings.

B. Concrete Anchor Design:

An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, it shall be considered an engineered design and anchors shall be installed to the prescribed size, spacing, embedment depth and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the anchors will be considered an engineered design and the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated by the Engineer on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

1. Structural Anchors: All concrete anchors shall be considered structural anchors if they transmit load between structural elements; transmit load between non-structural components that make up a portion of the structure and structural elements; or transmit load between life-safety related attachments and structural elements. Examples of structural concrete anchors include but are not limited to column anchor bolts, anchors supporting non-structural walls, sprinkler piping support anchors, anchors supporting heavy, suspended piping or equipment, anchors supporting barrier rails, etc. For structural anchors, the Contractor shall submit an engineered design with signed and sealed calculations performed by an Engineer currently registered in the Commonwealth of Virginia. Structural anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Appendix D.

2. Non-Structural Anchors: All other concrete anchors may be considered non-structural concrete anchors. The Contractor shall perform an engineered design for non-structural anchors. The Engineer may request the Contractor provide anchor design details for review, but submission of a signed, sealed design is not required. Non-structural anchors shall be designed by the contractor for use in uncracked concrete.

3. Embedment Depth

    a. Minimum anchor embedment shall be as indicated on the Drawings or determined by the Contractor's engineered design. Although all manufacturers listed are permitted, the embedment depth indicated on the Drawings is based on Pure 110+ by Powers Fasteners" If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.

    b. Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer's standard embedment (expansion or mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod according to the manufacturer (adhesive anchors).

    c. The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long term temperature of 110 degrees F, and maximum short term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum or more than the maximum stated in the manufacturer's literature.

C. Structural Anchors:

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Powerstud SD-1" or "Powerstud SD-2" by Powers Fasteners.

b. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Wedge-Bolt +" by Powers Fasteners. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.

c. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by Powers Fasteners.

d. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by Powers Fasteners

2. Adhesive Anchors:

a. Adhesive anchors shall be "Epcon C6+ Adhesive Anchoring System" by ITW Redhead, "HIT HY-200 Adhesive Anchoring System" by Hilti, Inc., SET-XP Epoxy Adhesive Anchors" by Simpson Strong-Tie Co., or "Pure 110+ Epoxy Adhesive Anchor System" by Powers Fasteners.

b. Structural adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

D. Non-Structural Anchors: In addition to the acceptable non-structural anchors listed below, all structural anchors listed above may also be used as non-structural anchors.

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt 3" by Hilti, Inc., "Wedge-All" by Simpson Strong-Tie Co. or "TruBolt" by ITW Redhead.

b. Screw Anchors: Screw anchors shall be "Kwik HUS" by Hilti, Inc., "Wedge-Bolt" by Powers Fasteners "Large Diameter Tapcon (LDT) Anchor" by ITW

Redhead, or “Titen HD” by Simpson Strong-Tie Co. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.

c. Sleeve Anchors: Sleeve anchors shall be “HSL Heavy Duty Sleeve Anchors” by Hilti, Inc. “Power-Bolt” by Powers Fasteners “Dynabolt Sleeve Anchor” by ITW Redhead, or “Sleeve-All” by Simpson Strong-Tie Co.

d. Drop-In Anchors: Drop-in anchors shall be “Drop-In” by Simpson Strong-Tie Co., “HDI Drop-In Anchor” by Hilti, Inc. or “Multi-Set II Drop-In Anchor” by ITW Redhead.

e. Undercut Anchors: Undercut anchors shall be “HDA Undercut Anchor” by Hilti, Inc., or “Torq-Cut” by Simpson Strong-Tie Co.

2. Adhesive Anchors:

a. Adhesive anchors shall be “Epcon A7” or “Epcon C6+ Adhesive Anchoring System” by ITW Redhead, “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET Epoxy Tie High Strength Anchoring Adhesive” or “AT High Strength Anchoring Adhesive” by Simpson Strong-Tie Co., or “Powers AC 100+ Gold Vinylester Injection Adhesive Anchoring System” or “T308+ Epoxy Adhesive Injection System” by Powers Fasteners.

b. Non-structural adhesive anchors systems shall be IBC compliant and capable of resisting short term wind and seismic (Seismic Design Categories A and B) as well as long term and short term sustained static loads in uncracked concrete.

c. Non-structural adhesive anchor embedment depth of the rod shall provide a minimum allowable bond strength that is equal to the allowable yield capacity of the rod unless noted otherwise on the Drawings.

d. No or equal products will be considered unless prequalified and approved by the Engineer and Owner.

E. Concrete Anchor Rod Materials:

1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer’s recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.

2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.

3. Nuts, washers, and other hardware shall be of a material to match the anchors.

2.05 MASONRY ANCHORS

A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.

B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust with nylon (not wire) brush prior to installation of adhesive and anchor. Contractor shall follow manufacturer's installation instructions. The adhesive system shall be "HIT HY-70 System" as manufactured by Hilti, Inc., or "SET-XP Epoxy-Tie or "AT-XP Acrylic-Tie" as manufactured by Simpson Strong-Tie Co.

C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, masonry anchors shall also be galvanized.

D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

2.06 WELDS

A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).

B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.

C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.07 WELDED STUD CONNECTORS

A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.08 EYEBOLTS

A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.09 HASTELLOY FASTENERS

A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

2.10 ANTISEIZE LUBRICANT

A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

PART 3 -- EXECUTION

3.01 MEASUREMENTS

A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 ANCHOR INSTALLATION

A. Anchor Rods, Concrete Anchors, and Masonry Anchors

1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.

2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.

3. Concrete anchors shall not be used in place of anchor rods without Engineer's approval.

4. All stainless steel threads shall be coated with antiseize lubricant.

B. High Strength Bolts

1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". All bolted joints shall be Type N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

C. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days, have a minimum compressive strength of 2500 psi, and shall be at least 50 degrees F.

2. Concrete anchors designed by the Contractor shall be classified as structural or non-structural based on the requirements indicated above.

3. Concrete Anchor Testing:

a. At all locations where concrete anchors meet the requirements for structural anchors at least 25 percent of all concrete anchors installed shall be proof tested to the value indicated on the Drawings, with a minimum of one tested anchor per anchor group. If no test value is indicated on the Drawings but the installed anchor meets the requirements for structural anchors, the Contractor shall notify the Engineer to allow verification of whether anchor load proof testing is required.

b. Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Proof testing of anchors shall be in accordance with ASTM E488 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.

c. Where Contract Documents indicate anchorage design to be the Contractor's responsibility and the anchors are considered structural per the above criteria, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the Commonwealth of Virginia. The Contractor's Engineer shall also submit documentation indicating the Contractor's proof testing procedures have been reviewed and the proposed procedures are acceptable. Proof testing procedures shall be in accordance with ASTM E488.

d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.

e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all proof testing, including additional testing required due to previously failed tests.

4. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.

5. All holes shall be drilled in accordance with the manufacturer's instructions except that cored holes shall not be allowed unless specifically approved by the Engineer. If cored holes are allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with the manufacturer's instructions prior to installation of adhesive and threaded rod unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water-saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer. Injection of adhesive into the hole shall be performed to minimize the formation of air pockets in accordance with the manufacturer's instructions. Wipe rod free from oil that may be present from shipping or handling.

D. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.

2. All stainless steel bolts shall be coated with antiseize lubricant.

3.03 WELDING

A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.04 INSPECTION

A. High strength bolting will be visually inspected in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Rejected bolts shall be either replaced or retightened as required.

B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.05 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

- END OF SECTION -

SECTION 05061S

STAINLESS STEEL

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. The Offeror shall furnish and the Contractor shall install and erect the stainless steel work as shown on the Contract Drawings and specified herein.

B. Stainless steel work shall be furnished complete with all accessories, mountings and appurtenances of the type of stainless steel and finish as specified or required for a satisfactory installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01302S - Submittals

B. Section 05010S - Metal Materials

C. Section 05050S - Metal Fastening

D. Section 05500S - Metal Fabrications

1.03 REFERENCES

A. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

B. ASTM A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

C. ASTM A262 - Practice for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel.

D. ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.

E. ASTM A314 - Stainless and Heat-Resisting Steel Billets and Bars for Forging.

F. ASTM A380 - Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.

G. ASTM A473 - Stainless and Heat-Resisting Steel Forgings.

H. ASTM A666 - Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar.

I. ASTM A774 - Stainless Steel Pipe Fittings

J. ASTM A778 - Stainless Steel Pipe

K. ASTM F593 - Stainless Steel Bolts, Hex Cap Screws and Studs.

L. ASTM F594 - Stainless Steel Nuts.

M. ANSI/ASME B1.1 - Unified Inch Screw Thread (UN and UNR Thread Form).

1.04 TESTS

A. All stainless steel materials including stainless test welds, shall be checked for compliance with tests for susceptibility to intergranular attack. Such tests shall be Practices A, B and E of ASTM A262. Detailed procedures for the tests shall be submitted to the Engineer for approval prior to start of work. Practice A shall be used only for acceptance of materials but not for rejection of materials, and shall be used for screening material intended for testing in Practice B and Practice E. The maximum acceptable corrosion rate under Practice B shall be 0.004 inch per month, rounded off to the third decimal place. If the certified mill report indicates that such test has been satisfactory performed, the fabricator may not be required to repeat the test. Material passing Practice E shall be acceptable.

B. Sample selection for the susceptibility to intergranular attack tests shall be as follows:

1. One (1) sample per heat per heat treatment lot for plates and forgings;

2. One (1) sample per each Welding Procedure Qualification regardless of the joint design;

3. If tests indicate a reduction in corrosion resistance, welding procedure shall be adjusted or heat treatment determined as needed to restore required corrosion resistance.

4. The samples so chosen shall have received all the post-weld heat treatments identical to the finished part.

1.05 SUBMITTALS

A. The Offeror shall prepare and submit for approval shop drawings for all stainless steel fabrication in accordance with Section 01302S, Submittals.

B. Submittals shall include, but not be limited to, the following:

1. Certified test reports for susceptibility to intergranular attack.

2. Affidavit of compliance with type of stainless steel shown on the Contract Drawings or specified herein.

3. Certified weld inspection reports.

4. Cleaning and handling of stainless steel in accordance with Paragraph 3.04, Cleaning and Handling.

C. Samples of finish, on each type of stainless steel to be furnished, shall be submitted to the Engineer upon request.

1.06 QUALITY ASSURANCE

A. Shop inspections may be made by the Engineer. The Offeror shall give ample notice to the Engineer prior to the beginning of any stainless steel fabrication work so that inspection may be provided. The Offeror shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the works.

B. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of the Contract Drawings or the Specifications.

C. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Offeror from his responsibility for furnishing proper materials or workmanship.

1.07 HANDLING, STORAGE AND DELIVERY

A. Mechanical damage (e.g., scratches and gouges) to the stainless steel material shall not be permitted and is cause for rejection. Care shall be taken in the material handling since such mechanical damage will result in the passive oxide film being "punctured" leading to a possible lower resistance to the initiation of corrosion than the surrounding chemically-passivated surface.

B. Stainless steel plates and sheets shall be stored vertically in racks and not be dragged out of the racks or over one another. Racks shall be protected to prevent iron contamination.

C. Heavy stainless steel plates shall be carefully separated and chocked with wooden blocks so that the forks of a fork-lift could be inserted between plates without mechanically damaging the surface.

D. Stainless steel plates and sheets laid out for use shall be off the floor and be divided by wooden planks to prevent surface damage and to facilitate subsequent handling.

E. Plate clamps, if used, shall be used with care as the serrated faces can dig in, indent and gouge the surface.

F. Stainless steel fabrications shall be loaded in such a manner that they may be transported and unloaded without being overstressed, deformed or otherwise damaged.

G. Stainless steel fabrications and packaged materials shall be protected from corrosion and deterioration and shall be stored in a dry area. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with approved effective and durable covers.

H. Stainless steel fabrications shall not be placed in or on a structure in a manner that might cause distortion or damage to the fabrication. The Contractor shall repair or replace damaged stainless steel fabrications or materials as directed by the Engineer.

1.08 FIELD MEASUREMENTS

A. The Offeror shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.

B. The Offeror shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

PART 2 -- PRODUCTS

2.01 MATERIALS AND FINISHES

A. Stainless steel shall be Type 304 unless it is used for underwater service. Stainless steel for underwater service shall be Type 316. Minimum mechanical finish shall be No. 4 as stated in Table 2 unless otherwise noted on the Contract Drawings.

B. The basic mill forms (sheet, strip, plate and bar) are classified by size as shown on Table 1. Tables 2, 3 and 4 identify finishes and conditions in which sheet, bar and plate are available.

C. Tables 2, 3 and 4 show numbered finishes and conditions for sheet, bar and plate. While there are no specific designations for polished finishes on bar or plate, the sheet finish designations are used to describe the desired effect. This also applies to finishes on ornamental tubing.

D. There are three standard finishes for strip, which are broadly described by the finishing operations employed:

1. No. 1 Strip Finish

   No. 1 strip finish is approximately the same as No. 2D Sheet Finish. It varies in appearance from dull gray matte to a fairly reflective surface, depending largely on alloy composition and amount of cold reduction.

2. No. 2 Strip Finish is approximately the same as a No. 2B sheet finish. It is smoother, more reflective than No. 1, and likewise varies with alloy composition.

3. Bright annealed finish is a highly reflective finish that is retained by final annealing in a controlled atmosphere furnace.

Table 1

Classification of Stainless Steel Product Form

Item	Description	Dimensions		
		Thickness	**Width**	**Diameter or Size**
Sheet	Coils and cut length: Mill finishes Nos. 1, 2D and 2B Polished finishes Nos. 3, 4, 6, 7 & 8	 under 3/16" under 3/16"	 24" and over all widths	 -- --
Strip	Cold finished, coils or cut lengths Polished finishes Nos. 3, 4, 6,7 & 8	under 3/16" under 3/16"	under 24" all widths	-- --
Plate	Flat rolled or forged	3/16" and over	over 10"	--
Bar	Hot finished rounds, squares, octagons and hexagons Hot finished flats Cold finished rounds, squares, octagons and hexagons Cold finished flats	-- 1/8" to 8" incl. -- 1/8" to 4-1/2"	-- 1/4" to 10" incl. -- 3/8" to 4-1/2"	1/4" and over -- over 1/8" --
Wire	Cold finishes only: (in coil) Round, square, octagon, hexagon and flat wire	 under 3/16"	 under 3/8"	 --
Pipe & Tubing	Several different classifications, with differing specifications, are available.			
Extrusion	Not considered “standard” shapes. Currently limited in size to approximately 6-1/2" diameter or structurals.			

Table 2

Standard Mechanical Sheet Finishes

Unpolished or Rolled Finishes: No. 1	A rough dull surface which results from hot rolling to the specified thickness followed by annealing and descaling.	No. 4	A polished surface obtained by finishing with a 120-150 mesh abrasive, following initial grinding with coarser abrasives. This is a general purpose bright finish with a visible "grain" which prevents mirror reflection.
No. 2D	A dull finish which results from cold rolling followed by annealing and descaling, and may perhaps get a final light roll pass through unpolished rolls. A 2D finish is used where appearance is of no concern.	No. 6	A dull satin finish having lower reflectivity than No. 4 finish. It is produced by Tampico brushing the No. 4 finish in a medium of abrasive and oil. It is used for architectural applications and ornamentation where a high luster is undesirable, and to contrast with brighter finishes.
No. 2B	A bright cold-rolled finish resulting in the same manner as No. 2D finish, except that the annealed and descaled sheet receives a final light roll pass through polished rolls. This is the general purpose cold-rolled finish that can be used as is, or as a preliminary step to polishing.	No. 7	A high reflective finish that is obtained by buffing finely ground surfaces but not to the extent of completely removing the "grit" lines. It is used chiefly for architectural and ornamental purposes.
Polished Finishes: No. 3	An intermediate polish surface obtained by finishing with a 100 grit abrasive. Generally used where a semi-finished polished surface is required. A No. 3 finish usually receives additional polishing during fabrication.	No. 8	The most reflective surface, which is obtained by polishing with successively finer abrasives and buffing extensively until all grit lines from preliminary grinding operations are removed. It is used for applications such as mirrors and reflectors.

Table 3

Conditions and Finishes for Bar

Conditions	Surface Finishes[1]
Hot worked only	(a) Scale not removed (excluding spot conditioning) (b) Rough turned[2] (c) Pickled or blast cleaned and pickled.
Annealed or otherwise heat treated.	(a) Scale not removed (excluding spot conditioning) (b) Rough turned (c) Pickled or blast cleaned and pickled (d) Cold drawn or cold rolled (e) Centerless ground (f) Polished
Annealed and cold worked to high tensile strength[3]	(d) Cold drawn or cold rolled (e) Centerless ground (f) Polished

[1] Surface finishes (b), (e) and (f) are applicable to round bars only.

[2] Bars of the 4xx series stainless steels which are highly hardenable, such as Types 414, 420, 420F, 431, 440A, 440B and 440C, are annealed before rough turning. Other hardenable grades, such as Types 403, 410, 416 and 416Se, may also require annealing depending on their composition and size.

[3] Produced in Types 302, 303Se, 304 and 316.

Table 4

Conditions and Finishes for Plate

Condition and Finish	**Description and Remarks**
Hot rolled	Scale not removed. Not heat treated. Plates not recommended for final use in this condition.[4]
Hot rolled, annealed or heat treated	Scale not removed. Use of plates in this condition is generally confined to heat resisting applications. Scale impairs corrosion resistance.[1]
Hot rolled, annealed or heat treated, blast cleaned or pickled	Condition and finish commonly preferred for corrosion resisting and most heat resisting applications.
Hot rolled, annealed, descaled and temper passed	Smoother finish for specialized applications.
Hot rolled, annealed, descaled cold rolled, annealed, descaled, optionally temper passed	Smooth finish with greater freedom from surface imperfection than the above.
Hot rolled, annealed or heat treated, surface cleaned and polished	Polished finishes refer to Table 2.

[4] Surface inspection is not practicable on plates which have not been pickled or otherwise descaled.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Holes for bolts and screws shall be drilled. Fastenings shall be concealed where practicable. Joints exposed to the weather shall be formed to exclude water.

B. As far as practicable, all fabricated units shall be fitted and assembled in the shop, with all cuts and bends made to precision measurements in accordance with details shown on approved shop drawings.

C. Work shall be fabricated so that it is installed in a manner that will provide for expansion and contraction, prevent the shearing of bolts, screws and other fastenings, ensure rigidity, and provide close fitting of sections.

D. All finished and/or machined faces shall be true to line and level. Stainless steel sections shall be well formed to shape and size with sharp lines and angles; curved work shall be sprung evenly to curves.

E. All work shall be fitted together at the shop as far as possible, and delivered complete and ready for erection. Proper care shall be exercised in handling all work so as not to injure the finished surfaces.

3.02 WELDING

A. Welding shall be done in a manner that will prevent buckling and in accordance with Specification 05050S – Metal Fastening, and as modified hereinafter.

B. All welds exposed in the work shall be ground smooth and finished to match the finish of the adjacent stainless steel surfaces.

C. Select weld rods that provide weld filler metal having corrosion resistant properties as nearly identical or better than the base metal to insure preservation of the corrosion-resistant properties. Provide heat treatment at welds where testing of weld procedure indicates it is required to restore the corrosion resistance.

D. Thermal conductivity of stainless steel is about half that of other steels; and the following methods may be used to accommodate this situation:

1. Use lower weld current setting.

2. Use skip-weld techniques to minimize heat concentration.

3. Use back-up chill bars or other cooling techniques to dissipate heat.

E. Edges of the stainless steel to be welded shall be cleaned of contaminants.

3.03 FASTENERS

A. Stainless steel fasteners shall be used for joining stainless steel work.

B. Stainless steel fasteners shall be made of alloys that are equal to or more corrosion resistant than the materials they join.

3.04 CLEANING AND HANDLING

A. All stainless steel surfaces shall be precleaned, descaled, passivated and inspected before, during and after fabrication in accordance with the applicable sections of ASTM A380 and as detailed in the procedures to be submitted to the Engineer for approval prior to start of work. Degreasing and passivation of stainless steel articles shall be conducted as the last step after fabrication.

B. Measures to protect cleaned surfaces shall be taken as soon as final cleaning is completed and shall be maintained during all subsequent handling, storage and shipping.

1. The Contractor shall submit for approval specific procedures listing all the steps to be followed in detecting contamination and in descaling, cleaning, passivation and protecting of all stainless steel.

2. Area showing clear indications of contamination shall be recleaned, repassivated and reinspected.

C. At approved stages in the shop operations, contaminants such as scale, embedded iron, rust, dirts, oil, grease and any other foreign matter shall be removed from the metal, as directed or approved by the Engineer. The adequacy of these operations shall be checked by the Engineer. Operations in the shop shall be conducted so as to avoid contamination of the stainless steel and to keep the metal surfaces free from dirt and foreign matter.

D. In order to prevent incipient corrosion during fabrication, special efforts shall be made at all times to keep all stainless steel surfaces from coming in contact with other metals.

1. Stainless steel and stainless steel welds shall be cleaned with clean sand free of iron, stainless steel wool, stainless steel brushes, or other approved means and shall be protected at all times from contamination by any materials, including carbon steel, that shall impair its resistance to corrosion.

2. Approved methods of cutting, grinding and handling shall be used to prevent contamination. If air-arc, or carbon-arc cutting is used, additional metal shall be removed by approved mechanical means so as to provide clean, weldable edges. All grinding of stainless steel shall be performed with aluminum oxide or silicon carbide grinding wheels bonded with resin or rubber. Grinding wheels used on carbon steel shall not be used on stainless steel.

3. Sand, grinding wheels, brushes and other materials used for cleaning stainless steel shall be checked periodically by the Engineer for contaminants. Cleaning aids found to contain contaminants shall not be used on the work.

3.05 INSTALLATION

A. All stainless steel fabrications shall be erected square, plumb and true, accurately fitted, adequately anchored in place, set at proper elevations and positions.

B. All inserts, anchor rods and all other miscellaneous work specified in the Detailed Specifications or shown on the Contract Drawings or required for the proper completion of the work, which are embedded in concrete, shall be properly set and securely held in position in the forms before the concrete is placed.

C. All stainless steel fabrications shall be installed in conformance with details shown on the Contract Drawings or on the approved shop drawings.

-END OF SECTION -

SECTION 05120S

STRUCTURAL STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010S - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050S - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.

1. Virginia Uniform Statewide Building Code

2. AISC - "Code of Standard Practice."

3. AISC - "Specification for Structural Steel Buildings".

4. AISC 348 - "The 2009 RCSC Specification for Structural Joints".

5. AWS - "Structural Welding Code".

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01302S, Submittals.

1. Certified Mill Test Reports

2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:

a. Layout drawings indicating all structural shapes, sizes, and dimensions.

b. Beam and column schedules.

c. Detailed drawings indicating jointing, anchoring and connection details.

1.05 QUALITY ASSURANCE

A. Shop inspection may be required by the Owner at his own expense. The Offeror shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Offeror shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Offeror from his responsibility for furnishing proper materials or workmanship under this Specification.

B. The erector shall be a qualified installer who participates in the AISC Certification program and is designated an AISC Certified Erector, Category ACSE.

C. The fabricator shall be a qualified fabricator who participates in the AISC Certification program and is designated an AISC Certified Plant, Category STD**.**

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Structural Steel

1. Structural steel for W shapes shall conform to ASTM A992 unless otherwise indicated.

2. Structural steel for HP shapes shall conform to ASTM A572 Grade 50 unless otherwise indicated.

3. Structural steel for S, M, C, and MC shapes and angles and plates shall conform to ASTM A36 unless otherwise indicated.

4. Steel pipe shall be ASTM A53, Grade B.

5. HSS shall be ASTM A500, Grade C or ASTM A1085. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.

6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Offeror, all at the expense of the Offeror.

7. Fasteners for structural steel shall be in accordance with Section 05050S, Metal Fastening.

B. Welds

1. Electrodes for welding shall be in accordance with Section 05050S, Metal Fastening.

PART 3 -- EXECUTION

3.01 MEASUREMENT

A. The Offeror shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Offeror shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

A. Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.

B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.

C. All holes in structural steel members required for anchors, anchor rods, bolts, sag rods or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.

D. All materials shall be properly worked and match-marked for field assembly.

E. Where galvanizing of structural steel is required, it shall be done in accordance with Section 05035, Galvanizing.

3.03 DELIVERY, STORAGE AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.

C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.

D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.

E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050S, Metal Fastening.

F. All bolted connections shall use high strength bolts in accordance with Section 05050S, Metal Fastening. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Bolts specified or noted on the Drawings to be a tension or slip critical "SC" type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.

G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

3. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.

2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.

4. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

A. Painting shall be performed according to Section 09900S, Painting and the following additional requirements.

1. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.

2. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.

3. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

4. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

- END OF SECTION -

SECTION 05140S

STRUCTURAL ALUMINUM

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to provide all structural aluminum work in accordance with the Contract Documents. The term "structural aluminum" shall include items as defined in the Aluminum Association "Specifications for Aluminum Structures".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010S - Metal Materials

B. Section 05050S - Metal Fastening

C. Section 09900S - Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of the Bid.

1. Virginia Uniform Statewide Building Code

2. Aluminum Association "Specifications for Aluminum Structures"

3. AWS D1.2 - "Structural Welding Code".

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01302S, Submittals.

1. Certified Mill Test Reports

2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:

a. Layout drawings indicating all structural shapes, sizes, and dimensions.

b. Beam and column schedules.

c. Detailed drawings indicating jointing, anchoring and connection details.

1.05 QUALITY ASSURANCE

A. Shop inspection may be required by the Owner at his own expense. The Offeror shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Offeror shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Offeror from his responsibility for furnishing proper materials or workmanship under this Specification.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Structural aluminum shall comply with Section 05010S, Metal Materials.

B. Fasteners for structural aluminum shall be in accordance with Section 05050S, Metal Fastening.

C. Electrodes for welding shall be in accordance with Section 05050S, Metal Fastening.

PART 3 -- EXECUTION

3.01 MEASUREMENT

A. The Offeror shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Offeror shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

A. Fabrication shall be in accordance with the Aluminum Association "Specifications for Aluminum Structures". Fabrication shall begin only after Shop Drawing approval.

B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.

C. All holes in structural aluminum members required for anchors, anchor rods, bolts, or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.

D. All materials shall be properly worked and match-marked for field assembly.

3.03 DELIVERY, STORAGE AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

B. Structural aluminum members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

A. All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before being permanently fastened.

C. No cutting of structural aluminum members in the field will be allowed except by the written approval of the Engineer.

D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.

E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050S, Metal Fastening.

F. All bolted connections shall comply with Section 05050S, Metal Fastening.

G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

3. Where misalignment between anchor bolts and bolt holes in aluminum members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.

2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.

4. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

A. Painting shall be performed according to Section 09900S, Painting.

B. Aluminum surfaces in contact with concrete or dissimilar metals shall be thoroughly protected with two coats of epoxy paint with a minimum total thickness of 16 mils or other approved isolating material in accordance with the requirements of Section 09900S - Painting.

- END OF SECTION -

SECTION 05500S

METAL FABRICATIONS

PART 1 -- GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal fabrications not specifically included in other Sections, complete and in accordance with the requirements of the Contract Documents.

B. Work shall include but may not be limited to lintels, guard posts, hoppers, and chutes.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010S - Metal Materials

B. Section 05050S - Metal Fastening

C. Section 05035 - Galvanizing

D. Certain specific items are included in other Sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Virginia Uniform Statewide Building Code

2. AISC - Specification for Structural Steel Buildings

3. AISI - Specifications for the Design of Cold-Formed Steel Structural Members

4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01302S, Submittals.

1. Complete fabrication and erection drawings of all metalwork specified herein.

2. Other submittals as required in accordance with Section 05010S, Metal Materials, and Section 05050S, Metal Fastening.

PART 2 -- PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used in metal fabrications shall conform to Section 05010S, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used in metal fabrication shall conform to Section 05050S, Metal Fastening, unless noted otherwise.

2.03 LINTELS

A. Provide lintels as shown on the Drawings and specified herein with 8 inches minimum bearing each side unless noted otherwise.

B. All lintels shall be steel in accordance with Section 05120S, Structural Steel, and shall be galvanized in accordance with Section 05035, Galvanizing, unless noted otherwise.

2.04 GUARD POSTS (BOLLARDS)

A. Guard posts shall be 6-inch diameter Schedule 40 galvanized steel pipe in accordance with ASTM A53.

B. Guard posts shall be concrete filled and crowned, as detailed in the Drawings.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Offeror prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050S, Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in Section 09900S, Painting.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions

C. Metal work shall be field painted when as specified in accordance with Section 09900S, Painting.

- END OF SECTION –

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SECTION 05830S

BEARING DEVICES AND ANCHORING

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. The Contractor shall furnish and install bearing plates, pads, expansion devices, anchor rods and bolts and/or other devices used in conjunction with bearings and anchoring of bearing devices and assemblies at supports in accordance with this item and in conformity with the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010S - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050S - Metal Fastening

D. Section 05120S - Structural Steel

E. Section 05140S - Structural Aluminum

F. Section 09900S - Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified hereunder shall conform to the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

1.	RMA Rubber Handbook	A4-F3-T.063-B2, Grade 2, Method B
2.	ASTM A240,	Standard Specification for Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plate and Sheet
3.	ASTM A480	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
4.	ASTM D395, Method B	Standard Test for Rubber Property – Compression Set
5.	ASTM D412	Standard Test for Rubber Properties In Tension

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6.	ASTM D471	Standard Test for Rubber Property - Effect of Liquids
7.	ASTM D573	Standard Test for Rubber-Deterioration In Air Oven
8.	ASTM D575, Method A	Standard Test for Rubber Properties In Compression
9.	ASTM D624, Die C	Standard Test for Rubber Property - Tear Resistance
10.	ASTM D746	Standard Test for Brittleness Temperature of Plastics and Elastomers by Impact
11.	ASTM D792	Standard Test for Specific Gravity and Density of Plastics by Displacement
12.	ASTM D1149	Standard Test for Rubber Deterioration - Surface Ozone Cracking In a Chamber (Flat Specimens)
13.	ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40
14.	ASTM D2240	Standard Test for Rubber Property - Durometer Hardness
15.	ASTM D2256	Standard Test for Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method
16.	ASTM D4894	Standard Specification for PTFE Granular Molding and RPM Extension Materials
17.	ASTM D4895	Standard Specification for PTFE Resin Produced From Dispersion

1.04 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01302S, Submittals:

1. Certification of compliance that the materials furnished under this section meet and conform to the property and physical requirements, including all testing, as stated herein and as referenced. Specifically, the certification shall state compliance with the applicable standards (ASTM, ANSI, etc.) for fabrication and testing.

2. Shop Drawings for all materials, including installation and adjustment instructions. Included with the Shop Drawings shall be all material certifications, mill test results, working drawings, etc., which are required by this and other applicable sections of the Specifications.

PART 2 -- PRODUCTS

2.01 ELASTOMERIC BEARING PADS

A. The elastomer portion of pads shall be new neoprene compound. Pads shall be cast under heat and pressure and may be individually molded or cut from pressure-cast stock. Variations from the dimensions shown on the Drawings shall not be more than the following: thickness, ±1/16 inch; width, -1/8 to +1/4 inch; length, -1/8 to +1/4 inch. Tolerances, dimensions, finish and appearance, flash, and rubber-to-metal bonding shall conform to the requirements of A 4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be furnished in one piece and shall not be laminated unless otherwise specified. Pads shall be furnished in identifiable packages.

B. Adhesive for use with elastomer pads shall be an epoxy-resin compound compatible with the elastomer having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikodur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

C. Laminated pads shall consist of alternate laminations of elastomer and hot-rolled steel sheets molded together as a unit. Outer metal laminations shall be 3/16 inch, and inner laminations shall be 14 gage. Outer laminations of elastomer shall be 1/4 inch, and inner laminations shall be of equal thickness (at least 3/8 but not more than 1/2 inch), depending on the number of laminations and thickness of the pad. Edges of metal laminations shall have a cover of approximately 1/8 inch of elastomer. The top and bottom bearing surfaces shall each have an integral sealing rib approximately 1/8 inch in depth, in addition to the specified total thickness, and 3/16 inch in width around their peripheries. The bond between the elastomer and metal shall be such that failure shall occur in the elastomer and not between the elastomer and steel when tested for separation. Variations from specified dimensions for individual laminations shall not be more than those specified herein. The total thickness of the complete pad shall not vary more than ±1/8 inch.

D. Material having a nominal durometer hardness of 70 and 50 shall be used for nonlaminated pads and laminated pads, respectively. Test samples will be prepared from finished pads. Samples of each thickness will be taken from 2 full-size pads from each shipment of 300 pads or less, with 1 additional pad for each additional increment of 300 pads or fraction thereof. When tested using the ASTM methods designated, samples shall comply with the following physical requirements.

1. **Original Physical Properties:** Test results for tear resistance, tensile strength, and ultimate elongation shall not be more than 10 percent below the following specified value:

	Nominal 50	**Hardness 70**
Min. tear resistance, ASTM D624, Die C (lb/in of thickness)	180	200
Hardness, ASTM D2240 (points)	50±5	70±5
Min. tensile strength, ASTM D412 (average psi of longitudinal and transverse)	2,500	2,500

Min. ultimate elongation (%)	400	300

The compressive deflection tested in accordance with ASTM D575, Method A, shall be as follows:

a. **Laminated Pads:** The maximum compression deflection shall be 5 and 7 percent of the total rubber thickness at loads of 500 and 800 pounds per square inch, respectively. The maximum shear resistance shall be 50 pounds per square inch of the plan area at 25 percent shear deformation at –20°F. Test pads shall be subjected to a compressive load of 1.5 times the maximum design load without visible damage to the bearing.

b. **Nonlaminated Pads:** When loaded within 300 to 800 pounds per square inch, material shall show a compressive deflection within 20 percent of that given in the charts of Method A, interpolating for actual measured hardness.

2. **Changes in Original Physical Properties:** When pads are oven aged 70 hours at 212°F in accordance with ASTM D573, changes shall not be more than the following:

Property	**Value**
Hardness (points change)	0 to +15
Tensile strength (% change)	±15
Ultimate elongation (% change)	-40

3. **Extreme Temperature Characteristics:** Compression set under constant deflection, ASTM D395, Method B, 22 hours at 212°F, shall not be more than 35 percent. With the low-temperature brittleness test, ASTM D746, breaks shall not occur above –20°F.

4. **Ozone Cracking Resistance:** Upon exposure to 100 parts per million of ozone in air by volume at a strain of 20 percent and a temperature of 100±2°F in a test otherwise in accordance with ASTM D1149, cracks shall not develop within 100 hours. Samples shall be wiped with solvent before the test to remove traces of surface impurities.

5. **Oil Swell:** The volume change shall not be more than +120 percent when tested in accordance with ASTM D471 with ASTM Oil No. 3, 70 hours at 212°F.

2.02 TFE BEARING SURFACES

A. TFE resin shall be virgin material conforming to the requirements of ASTM D4894 or D4895. The specific gravity shall be 2.13 to 2.19. The melting point shall be 623±2°F.

B. Filler material shall be milled glass fibers, carbon, or other approved inert filler materials.

C. Adhesive material shall be an epoxy resin conforming to FS MMM-A-134, FEB film or equal, as approved by the Engineer.

D. When tested in accordance with ASTM D4894 or D4895, finished unfilled TFE sheets shall have a tensile strength of at least 2,800 pounds per square inch and an elongation of at least 200 percent.

E. Filled TFE sheets shall contain inert filler material uniformly blended with TFE resin. Finished filled TFE sheets containing glass fiber or carbon shall conform to the following:

	ASTM Method	**15% Glass Fibers**	**25% Carbon**
Min. tensile strength	D4894/D4895	2,000 psi	1,300 psi
Min. elongation	D4894/D4895	150%	75%
Min. specific gravity	D792	2.20	2.10
Melting point	D4894/D4895	327±10°C	317 ±10°C

F. Fabric containing TFE fibers shall be manufactured from oriented multifilament TFE fluorocarbon fibers and other fibers as required by specific designs. When tested in accordance with ASTM D2256, the tensile strength of TFE fibers shall be at least 24,000 pounds per square inch and the elongation shall be at least 75 percent.

G. Where TFE sheets are to be epoxy bonded, one surface of the sheet shall be factory treated by an approved manufacturer using the sodium naphthalene or sodium ammonia process.

H. Stainless steel mating surfaces shall be at least 16 gage in thickness and shall conform to the requirements of ASTM A240, Type 304. The mating surface shall be a true plane surface with a Brinnell hardness of at least 125 and a surface finish of an at least No. 8 mirror finish in accordance with ASTM A480. Stainless steel mating surfaces shall be polished or rolled as necessary to conform to the friction requirements specified herein. The stainless steel shall be attached to the sole plate by means of a seal weld around the entire perimeter of the facing material.

I. The coefficient of friction for the completed bearing assembly shall not be more than the following:

Material	**Bearing Pressure**		
	500 psi (3.447 MPa)	**2,000 psi (13.790 Mpa)**	**3,500 psi (24.132 MPa)**
Unfilled TFE, fabric Containing TFE fibers, TFE perforated metal composite	.08	.06	.04
Filled TFE	.12	.10	.08
Interlocked bronze and filled TFE structures	.10	.07	.05

2.03 PREFORMED FABRIC BEDDING MATERIAL

A. Material shall be composed of multiple layers of 8-ounce cotton duck impregnated and bound with high-quality natural rubber or its equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plys shall be such as to produce the specified thickness after compression and vulcanizing. Finished pads shall withstand compression loads perpendicular to the plane of the laminations of at least 10,000 pounds per square inch without a detrimental reduction in thickness or extrusion.

2.04 ANCHOR RODS

A. Anchor bolts shall be as specified in Section 05050S, Metal Fastening.

2.05 PIPE SLEEVES AND COLLARS

A. Pipe sleeves and collars shall be cut from schedule 40 PVC plastic pipe meeting the requirements of ASTM D1785 unless otherwise noted on the Drawings.

PART 3 -- EXECUTION

3.01 STEEL PLATES, SHAPES, AND BARS

A. Unless galvanizing is indicated on the Drawings, items shall be painted in accordance with the Drawings and Section 09900S, Painting.

B. If galvanizing is indicated on the Drawings, steel bearing assemblies for both structural steel beams and girders and prestressed concrete members shall be galvanized as specified in Section 05035, Galvanizing. Except for attachments of bearing plates to beams, all fabrication and welding of bearing plate assemblies shall be performed before the steel is galvanized. All joints of welded parts shall be sealed with weld material. Welds made for attaching bearing plates to beams or girders shall be cleaned and given 2 coats of zinc rich paint having a minimum total coating thickness of 3 mils.

3.02 BRONZE PLATES

A. Sliding surfaces of bronze plates shall be polished.

3.03 COPPER-ALLOY PLATES

A. Finishing of rolled copper-alloy plates will not be required provided their surfaces are plane, true, and smooth.

3.04 SELF-LUBRICATING PLATES

A. Plates shall be fabricated from cast bronze or rolled copper alloy.

B. Sliding surfaces of plates shall be provided with annular grooves or cylindrical recesses or a combination thereof, which shall be filled with a lubricating compound. The lubricating compound shall be compressed into recesses under sufficient pressure to form a nonplastic lubricating inset. The inset shall comprise at least 25 percent of the total area of the plate. The frictional coefficient shall not be more than 0.10. The compound shall be free from material that will cause abrasive or corrosive action on metal surfaces and able to withstand extremely high pressures and atmospheric elements over long periods of time.

C. Items shall be the standard products of the manufacturer of such materials for the application.

D. Prior to assembly, the steel surface that will bear on the self-lubricating bearing plate shall be thoroughly lubricated with additional antioxidant lubricant furnished by the manufacturer. Coatings shall be removed before application of antioxidant lubricant.

3.05 ELASTOMERIC PADS

A. Care shall be taken in fabricating pads and related metal parts so that effects detrimental to their proper performance, such as uneven bearing and excessive bulging, will not occur.

3.06 PLACEMENT OF BEARING PLATES AND PADS

A. Bearing areas shall be finished to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area.

B. Bearing plates or pads shall be set level in exact position and shall have a uniform bearing over the entire area. Provision shall be made to keep plates or pads in the correct position during erection of beams or placement of concrete.

C. Elastomeric pads and other flexible bearing materials shall be placed directly on masonry surfaces finished to a roughness equivalent to that of a No. 36 to No. 46 grit. Pads, bearing areas, or bridge seats and metal bearing plates shall be thoroughly cleaned and free from oil, grease, and other foreign materials. Metal bearing plates or bottoms of prefabricated beams that are to bear on elastomeric pads shall be coated with epoxy and then surfaced with a No. 36 to No. 46 silicon carbide or aluminum oxide grit. Bearing areas shall be finished to equivalent roughness.

D. Metal bearing plates shall be bedded on seats as follows:

1. The seat bearing areas shall be thoroughly swabbed with approved paint, and three layers of duck, 12 to 15 ounce per square yard, shall be placed on it, each layer being thoroughly swabbed with paint on its top surface.

2. Superstructure shoes or pedestals shall be placed in position while paint is plastic. As an alternate to duct and paint, preformed fabric bedding material at least 1/8 inch in thickness may be used when called for on the Drawings or approved in writing by the Engineer.

3.07 PLACEMENT OF ANCHOR RODS

A. All necessary anchor rods and bolts (anchors) shall be accurately set either in the concrete as they are being placed, in formed holes, or in holes cored after the concrete has set. If set in the concrete, the rods and bolts shall be accurately positioned by means of templates and rigidly held in position while the concrete is being placed. Holes may be formed by inserting or casting in the fresh concrete oiled wooden plugs, metal pipe or plastic sleeves, or other approved devices, and withdrawing them after the concrete has partially set or left in place as indicated on the Drawing's or approved by the Engineer. Holes so formed shall be at least 3 inches in diameter or at least 2.5 times the diameter of the rod or bolt. If cored, holes shall be at least 2.5 times the diameter of the anchor used or as indicated on the Drawings. Equipment used for coring concrete shall have been approved by the Engineer. Impact tools will not be permitted. Reinforcing steel shall be placed to provide adequate space to core rod/bolt holes without cutting the reinforcing steel. For cored holes, anchor rods and bolts shall be adequately held in place at the centroid of the hole or as specified on the Drawings by using approved pre-fabricated equalizers designed to allow grout to penetrate and fill the hole completely and spaced as approved by the Engineer.

B. During freezing conditions, anchor holes shall be protected from water accumulations at all times.

C. Anchors which are to be placed in holes of sufficient and specified diameter after the concrete has set shall be bonded to the concrete with a non-shrink high-strength Portland cement grout in accordance with Section 03600 – Grout or shall be adhesive anchors in accordance with Section 05050S - Metal Fastening. The type anchoring system and grout shall be as indicated on the Drawings. The grout or adhesive shall completely fill the holes. Anchors shall be tested for sufficient pull-out capacity as indicated in applicable sections of the Specifications or as indicated on the Drawings.

D. Anchors that are not designed to project through bearing plates shall be checked for proper projection above the masonry bearing area immediately prior to placement of bearing plates and beams. Nuts on anchor rods at expansion ends shall be adjusted to permit free movement of the span.

E. Angles for anchor assemblies to be attached to sides of concrete beams shall not be installed until beams have received their full dead load and supporting falsework has been removed.

- END OF SECTION -

SECTION 09900S

PAINTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein.

B. Section Includes:

1. Paint Materials

2. Shop Painting

3. Field Painting

a. Surface Preparation

b. Piping and Equipment Identification

c. Schedule of Colors

d. Work in Confined Spaces

e. OSHA Safety Colors

1.02 RELATED SECTIONS

A. Section 15030S - Piping and Equipment Identification Systems

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:

1. SSPC – The Society for Protective Coatings Standards

a.	SSPC-Vis 1	Pictorial Surface Preparation Standards for Painting Steel Structures
b.	SSPC-SP2	Hand Tool Cleaning
c.	SSPC-SP3	Power Tool Cleaning
d.	SSPC-SP5	White Metal Blast Cleaning
e.	SSPC-SP6	Commercial Blast Cleaning

f. SSPC-SP10 Near-White Metal Blast

g. SSPC-SP13/NACE6 Surface Preparation of Concrete

2. NACE - National Association of Corrosion Engineers

3. ASTM D1737 - Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus

4. ASTM B117 - Method of Salt Spray (Fog) Testing

5. ASTM D4060 - Test Method for Abrasion Resistance of Organic Coating by the Taber Abraser

6. ASTM D3359 - Method for Measuring Adhesion by Tape Test

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01302S - Submittals, submit the following:

1. Manufacturer's literature and Material Safety Data Sheets for each product.

2. Painting schedule identifying surface preparation and paint systems proposed. Cross-reference with Tables 9-1 and 9-2. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items.

1.05 SYSTEM DESCRIPTION

A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenance.

B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.

C. Paint surfaces which are customarily painted, whether indicated to be painted or not, with painting system applied to similar surfaces, areas and environments, and as approved by Engineer.

D. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

1.06 QUALITY ASSURANCE

A. Painting operations shall be accomplished by skilled craftsman and licensed by the state to perform painting work.

B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.

1.07 STORAGE AND DELIVERY

A. Bring materials to the job site in the original sealed and labeled containers.

B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

PART 2 -- MATERIALS

2.01 GENERAL INFORMATION

A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.

B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared, products were properly applied, and the paint systems were proper for the exposure and service.

C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.

D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.

E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.

F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Tnemec Company Inc.

2. Ameron

3. CARBOLINE

4. Sherwin-Williams

5. International

PART 3 -- EXECUTION

3.01 SHOP PAINTING

A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.

B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints.

3.02 SURFACE PREPARATION

A. General

1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.

2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted

prior to cleaning and painting. Reposition items removed upon completion of painting operations.

3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.

4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.

5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch-up coats are in addition to the specified applied systems, and not considered a field coat.

6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.

7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

B. Metal Surface Preparation

1. Conform to current The Society for Protective Coatings Standards (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.

2. Perform blast cleaning operations for metal when following conditions exist:

   a. Moisture is not present on the surface.

   b. Relative humidity is below 80%.

   c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.

   d. Painting or drying of paint is not being performed in the area.

   e. Equipment is in good operating condition.

   f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.

3. Sandblast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.

4. Sandblast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service.

5. Sandblast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment.

6. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system.

7. Prime cleaned metals immediately after cleaning to prevent rusting.

8. Clean rusted metals down to bright metal by sandblasting and immediately field primed.

C. Concrete Surface Preparation

1. Cure concrete a minimum of 30 days before surface preparation, and painting begins.

2. Test concrete for moisture content, pH and salts using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.

3. Prepare concrete surfaces to receive coatings in accordance with SSPC-13 – Concrete Surface Preparation. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities using blasting or grinding. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall achieve profile as required by manufacturer or where not defined by manufacturer similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or other approved method.

4. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric filler compatible with painting system. Complete fill coats may be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.

5. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.

6. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.

D. Wood

1. Clean wood surfaces free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Remove sap and resin by scraping and wipe clean with rags dampened with mineral spirits.

2. Saturate end grain, cut wood, knots, and pitch pockets with an appropriate sealer before priming.

3. Prime and backprime wood trim before setting in place.

4. After prime coat has dried, fill nailholes, cracks, open joints, and other small holes with approved spackling putty. Lightly sand wood trim prior to applying second coat of paint.

E. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.

2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

F. Masonry

1. Cure for a minimum of 30 days prior to paint application.

2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.

3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

G. Gypsum Drywall

1. Sand joint compound with sandpaper to provide a smooth flat surface. Avoid sanding of adjacent drywall paper.

2. Remove dust, dirt, and other contaminants.

H. Previously-Painted Surfaces

1. Totally remove existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.

2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.

3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.

4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer's recommendations.

5. Check existing paints for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

3.03 APPLICATION OF PAINT

A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.

B. Apply paint without runs, sags, thin spots, or unacceptable marks.

C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.

D. Special attention shall be given to nuts, bolts, edges, angles, flanges, etc., where insufficient film thicknesses are likely. Stripe paint prior to applying prime coat. Stripe painting shall be in addition to coats specified.

E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.

F. Allow paint to dry a minimum of twenty-four hours between application of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.

G. Suspend painting when any of the following conditions exist:

1. Rainy or excessively damp weather.

2. Relative humidity exceeds 85%.

3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.

4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.

5. Surface temperature of item is within 5 degrees of dewpoint.

6. Dew or moisture condensation are anticipated.

7. Surface temperature exceeds the manufacturer's recommendations.

3.04 INSPECTION

A. Each field coat of paint will be inspected and approved by the Engineer or his authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.

B. Use magnetic dry film thickness gauges and wet fiber thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.

C. Coatings shall pass a holiday detector test.

D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.

E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.

1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.

2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.

F. Paint manufacturer or his representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES

A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.

B. Take all necessary precautions to contain dispersion of sandblasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the sandblasting debris and paint. Suspend painting operations when sanding debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

3.06 PIPING AND EQUIPMENT IDENTIFICATION

A. Piping and equipment identification shall be in accordance with Section 15030S, Piping and Equipment Identification Systems.

3.07 SCHEDULE OF COLORS

A. Match colors indicated. Piping and equipment colors are indicated in Section 15030S, Piping and Equipment Identification Systems. Colors which are not indicated shall be selected from the manufacturer's full range of colors by the Engineer. No variation shall be made in colors without the Engineer's approval. Color names and numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

3.08 WORK IN CONFINED SPACES

A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or direct air supply to individual workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosion-proof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state and local regulations at all times.

3.09 OSHA SAFETY COLORS

A. Paint wall around wall-mounted breathing or fire apparatus with the appropriate safety red color; area not exceed 2-feet wide by 3-feet high, unless apparatus covers the area. Fire apparatus include fire hoses, extinguisher, and hydrants.

B. Paint hazardous areas and objects in accordance with OSHA regulations.

TABLE 9-1
PAINTING SCHEDULE

SURFACE	APPLICATION	PAINTING SYSTEM & NO. OF COATS	PRODUCT REFERENCE (TABLE 9.2)	TOTAL MIN. DRY FILM THICKNESS (MILS)
Concrete and Masonry				
Interior masonry and concrete walls and ceilings	All new structures	1 coat sealer 2 coats acrylic epoxy	101 116	75-85 sq.ft./gal. 4-6/coat
Interior masonry and concrete walls in chemical rooms		1 coat sealer 2 coats epoxy polyamide	117 102	60-80 sq.ft./gal. 4-6/coat
Exterior masonry cavity walls on cavity face of inner wythe	All new structures	Dampproofing	See Section 07150	
Exterior below grade if interior is dry	Accessible areas (e.g. pipe galleries, pump rooms, basements, etc.)	Waterproofing	See Section 07100	
Submerged water	Water retaining side of new wall surfaces where opposite side of wall is interior and dry and where indicated "epoxy waterproofing" on drawing	2 coats NSF approved epoxy polyamide Provide filler as required and recommended by manufacturer	105	4-6/coat
Submerged wastewater		2 coats high solids epoxy Provide filler as required and recommended by manufacturer	119	6-10/coat
Containment Liner[1]	Interior and exterior secondary containment floors, tank supports and walls	2 coats high solids epoxy coating	119	6-10/coat
Metals				
Interior and exterior nonsubmerged (gloss)	All new blowers, pumps, motors and mechanical equipment, piping, etc.	1 coat epoxy polyamide primer 1 coat epoxy polyamide 1 coat aliphatic polyurethane	104 102 115	4-6 4-6 3-5
Interior insulated		1 coat acrylic latex	103	4
Submerged water	All metal piping, and mechanical equipment, etc.	2 coats NSF approved epoxy polyamide	105	4-6/coat
Submerged Wastewater		2 coats high solids epoxy	119	8-10/coat
Steel doors, windows and door frames, steel stairs, monorails, structural steel, misc. metals (steel)		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4
Aluminum surfaces in contact with concrete		2 coats coal tar	107	26
Shop Primed Structural Steel	Pre-Engineered Buildings	1 barrier coat 1 coat epoxy 1 coat epoxy	113 114 120	2-3 3-4 3-4

1. Painting manufacturer shall verify compatibility of containment liner and chemical to be contained. Where incompatible

substitute a compatible coating system.

TABLE 9-1
PAINTING SCHEDULE (CONTINUED)

SURFACE	APPLICATION	PAINTING SYSTEM & NO. OF COATS	PRODUCT REFERENCE (TABLE 9.2)	TOTAL MIN. DRY FILM THICKNESS (MILS)
Other Interior: Gypsum Wallboard	All new structures	2 coats acrylic latex matte or satin	103	2-3/coat
Interior: Tar-dipped piping where color is required		2 coats epoxy resin sealer 2 coats epoxy polyamide	112 102	5-8/coat 5-8/coat
PVC Piping		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4

TABLE 9-2

PRODUCT LISTING

REF.	SYSTEM	PURPOSE	PRODUCT Tnemec Series	PPG/AMERON	CARBOLINE	Sherwin-Williams
101	Acrylic filler	Primer-sealer	130-6601	BLOXFIL 4000	Sanitile 100	Cement-Plex 875
102	Epoxy polyamide	Finish coat semi-gloss or gloss	N69N69	AMERLOCK 2	Carboguard 890	Dura-Plate 235235
103	Acrylic latex	Sealer	1028/10291029	PITT TECH PLUS	Carbocrylic 3359DTM	DTM Acrylic Primer/Finish
104	Epoxy Polyamide – metal	Primer	66	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
105	Epoxy	Primer/Finish	20	AMERLOCK 2	Carboguard 561/56LT	Macropoxy 646 PW
106	Coal tar epoxy	Finish high-coat build	46H-413	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
107	Coal tar	Sealer	46-465	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
108	Alkyd-medium oil	Finish coat	2H	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
109	Alkyd-long oil	Finish coat	1029	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
110	Epoxy polyamide	Primer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
112	Epoxy polyamide	Sealer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 920 Pre-Prime
113	Urethane	Barrier coat	530	AMERLOCK SEALER	Rustbond	--
114	Polyamine Epoxy	Intermediate coat	27	AMERLOCK 385	Carboguard 893SG	--
115	Aliphatic Polyurethane	Finish coat	1074 or 1075	AMERCOAT 450 HS	Carbothane 134HG	Acrolon 218HS
116	Acrylic epoxy	Finish coat	113 or 114	AQUAPON WB	Sanitile 255	Water-Based Catalyzed Epoxy
117	Epoxy block filler	Sealer	12541254	AMERLOCK 114114	Sanitile 600	KemKem Cati-Coat HS Epoxy Filler
118	Catalyzed epoxy	Finish coat	84	AMERLOCK 2/400	Carboguard 890	Macropoxy 646
119	High solids epoxy	Finish coat	104	AMERLOCK 400	Carboguard 890	Dura-Plate 235
120	Epoxy	Top coat	N69	AMERLOCK 2/400	Carboguard 890	--

- END OF SECTION -

SECTION 11000S

EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The requirements of this section shall apply to the general construction contractor for the Expansion Project. This section serves as a reference for the Offeror. Loudoun Water will not directly award a purchase order for the goods and associated services for the Expansion Project but will instead assign the Procurement Agreement to the general construction contractor selected for the Expansion Project.

B. The Contractor shall furnish, install, test, and place in acceptable operation all mechanical equipment and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system.

C. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, and other appurtenances as specified, and as may be required for a complete and operating installation.

D. It is the intent of these Specifications that the Contractor shall provide the Owner complete and operational equipment/systems. To this end, it is the responsibility of the Contractor to coordinate all interfaces with related mechanical, structural, electrical, instrumentation and control work and to provide necessary ancillary items such as controls, wiring, etc., to make each piece of equipment operational as intended by the Specifications.

E. The complete installation shall be free from excessive vibration, cavitation, noise, and oil or water leaks.

F. The requirements of this section shall apply to equipment furnished under Divisions 11S, 13S, 14S, and 15S.

G. Reference Section 01652S, Project Commissioning, for additional requirements.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01090, Reference Standards.

1.04 SHOP DRAWINGS

A. Shop Drawings shall be submitted to the Engineer for all equipment in accordance with Section 01302S, Submittals and shall include the following information in addition to the requirements of Section 01302S, Submittals:

1. Performance characteristics and descriptive data.

2. Detailed equipment dimensional drawings and setting plans.

3. General lifting, erection, installation, and adjustment instructions, and recommendations.

4. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.

5. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.

6. Details on materials of construction of all components including applicable ASTM designations.

7. Information on bearing types and bearing life.

8. Gear box design and performance criteria and AGMA service factor.

9. Piping schematics.

10. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at ½, ¾, and full load; slip at full load; running, full load, and locked rotor current values; and safe running time-current curves.

11. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

12. Equipment shop coating systems, interior and exterior.

13. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.

14. A list of spare parts and special tools to be provided.

15. Any additional information required to show conformance with the equipment specifications.

16. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.

1.05 OPERATION AND MAINTENANCE INSTRUCTION/MANUALS

A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01302S, Submittals.

B. O&M manuals shall include instructions, equipment ratings, technical bulletins, and any other printed matter such as wiring diagrams and schematics, prints or drawings, containing full information required for the proper operation, maintenance, and repair of the equipment. Included in this submission shall be a spare parts diagram, complete spare parts list, bill of materials, OEM part numbers and manufacturer's catalog information of all equipment components.

C. Each set of instructions shall be bound together in appropriate three-ring binders with a detailed Table of Contents.

D. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item.

E. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission.

F. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.

G. Extensive pictorial cuts of equipment are required for operator reference in servicing.

H. When written instructions include Shop Drawings and other information previously reviewed by the Engineer, only those editions thereof which were approved by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the instructions.

1.07 GENERAL INFORMATION AND DESCRIPTION

A. All parts of the equipment furnished shall, be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all conditions of operation. All materials shall be new, and both workmanship and materials shall be entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.

B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.

C. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards.

D. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provision shall be made for accessible lubrication by extending lubrication lines and fittings to approximately 30 inches above finished floor elevation.

E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.

G. All machinery and equipment shall be safeguarded in accordance with the safety codes of the USA and the State in which the project is located.

H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with suitable protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.

I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.

J. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

1.08 EQUIPMENT WARRANTIES

A. Warranty requirements may be added to or modified in the individual equipment specifications.

B. The equipment furnished under this Contract shall be guaranteed to be free from defects in workmanship, design and/or materials for a period of one (1) year unless otherwise specified in the individual equipment specifications. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

C. The Contractor shall provide an equipment warranty log book prepared specifically for this project and submit two (2) copies of the document to the Engineer prior to final payment. The equipment warranty log book shall include a summary listing of all equipment warranties provided, date received, and start date and end date of warranty period. A copy of each equipment warranty and equipment start-up certification shall also be provided in the document.

D. The Equipment Supplier shall guarantee to the Owner that all equipment offered under these specifications, or that any process resulting from the use of such equipment in the manner stated is not the subject of patent litigation, and that he has not knowingly offered equipment, the installation or use of which is likely to result in a patent controversy, in which the Owner as user is likely to be made the defendant.

Where patent infringements are likely to occur, each Equipment Supplier shall submit, as a part of his bid, license arrangements between himself, or the manufacturer of the equipment offered, and the patent owner or the controller of the patent, which will permit the use in the specified manner of such mechanical equipment as he may be bidding.

Each Equipment Supplier, by submitting his bid, agrees to hold and save the Owner and Engineer or its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the work under this contract, including the use of the same by the Owner.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The materials covered by these Specifications are intended to be equipment of proven reliability, and as manufactured by reputable manufacturers having experience in the production of such equipment. The Contractor shall, upon request of the Engineer, furnish the names of not less than 5 successful installations of the manufacturer's equipment of the same size and model of that offered under this contract. The equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

2.02 ANCHORS AND SUPPORTS

A. The Contractor shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and suitable templates shall be used by the Contractor when required in the detailed equipment Specifications.

B. Anchor bolts and fasteners shall be furnished in accordance with Section 05050S, Metal Fastening, and with the individual equipment Specifications. All anchor bolts shall be a minimum of 1/2-inch diameter. All anchor bolts, handrail bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.

C. The Contractor shall provide all concrete pads or pedestals required for equipment furnished. All concrete equipment pads shall be a minimum of 6” high, unless otherwise shown on the Drawings and shall be doweled.

D. Pipe sleeves or other means of adjusting anchor bolts shall be provided where indicated or required. Equipment shall be leveled by first using sitting nuts on the anchor bolts, and then filling the space between the equipment base and concrete pedestal with non-shrink grout, unless alternate methods are recommended by the manufacturer and are acceptable to the Engineer (such as shim leveling pumps, or chemical grout).

2.03 STRUCTURAL STEEL

A. Structural steel used for fabricating equipment shall conform to the requirements of Section 05120S, Structural Steel.

B. All materials shall conform to applicable provisions of the AISC Specifications for the design and fabrication of structural steel, and to pertinent ASTM Standard Specifications.

2.04 DISSIMILAR METALS

A. All dissimilar metals shall be properly isolated to the satisfaction of the Engineer.

2.05 GALVANIZING

A. Where required by the equipment specifications, galvanizing shall be performed in accordance with Section 05035S, Galvanizing (not included with RFP and shall be included in Specifications developed for the Expansion Project).

2.06 STANDARDIZATION OF GREASE FITTINGS

A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be “Zerk” type.

2.07 ELECTRICAL REQUIREMENTS

A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 16S specifications and the latest National Electric Code.

B. Motors shall conform to the applicable requirements of Section 15170S, Low Voltage Electric Motors. Medium voltage motors shall conform to the applicable requirements of Section 15171S, Medium Voltage Electric Motors.

C. In the individual equipment specifications, specified motor horsepower is intended to be the minimum size motor to be provided. If a larger motor is required to meet the specified operating conditions and performance requirements, the Contractor shall furnish the larger sized motor and shall upgrade the electrical service (conduit, wires, starters, etc.) at no additional cost to the Owner.

D. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between equipment supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16S and shall be as specified in Section 16495S, Variable Frequency Drive Systems.

E. Motor starters and controls shall be furnished and installed under Division 16S and Division 17S unless otherwise specified in the individual pump specifications.

2.08 ACCESSORIES, SPARE PARTS, AND SPECIAL TOOLS

A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications or where recommended by the equipment manufacturer.

B. Spare parts shall be identical and interchangeable with original parts.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Painting requirements for spare parts shall be identical to those for original, installed parts. Where no painting or protective coating is specified, suitable provisions shall be made to protect against corrosion.

E. Spare parts shall be delivered at the same time as the equipment to which they pertain. Spare parts shall be stored separately in a locked area, maintained by the Contractor, and shall be turned over to the Owner in a group prior to substantial completion. All of these materials shall be properly packed, labeled, and stored where directed by the Owner and Engineer, as described in Section 01616S, Asset Management.

F. The Contractor shall furnish all special tools necessary to operate, disassemble, service, repair, and adjust the equipment in accordance with the manufacturers operation and maintenance manual.

G. The Contractor shall furnish a one year supply of all recommended lubricating oils and greases. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required. All of these materials shall be properly packed, labeled and stored where directed by the Engineer.

H. The Offeror shall be fully responsible for loss or damage to parts and materials until they are received by Loudoun Water.

2.09 EQUIPMENT IDENTIFICATION

A. Equipment identification shall be as specified in Section 01616S, Asset Management.

PART 3 -- EXECUTION

3.01 SHOP TESTING

A. All equipment shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.

B. No equipment shall be shipped to the project until the Engineer has been furnished a certified copy of test results and has notified the Contractor, in writing, that the results of such tests are acceptable.

C. Five (5) certified copies of the manufacturer's actual test data and interpreted results thereof shall be forwarded to the Engineer for review.

D. If required by the individual equipment Specifications, arrangements shall be made for the Owner/Engineer to witness performance tests in the manufacturer's shop. The Engineer shall be notified ten working days before shop testing commences. Expenses are to be paid by Contractor.

E. Shop testing of electric motors shall be in accordance with applicable requirements of Section 15170S, Low Voltage Electric Motors; Section 15171S, Medium Voltage Electric Motors; and Section 16000S, Basic Electrical Requirements.

3.02 STORAGE OF EQUIPMENT AND MATERIALS

A. Equipment and materials at the job site shall be stored in accordance with Section 01600S, Materials and Equipment, and General and Special Conditions.

B. Contractor shall store his equipment and materials at the job site in strict accordance with the manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations, and rulings of the public authority having jurisdiction. Equipment and materials shall not be delivered to the site prior to 90 days in advance of the scheduled installation. Partial payment requests will not be processed for materials delivered prior to 90 days before installation or for materials that are not properly stored.

B. Material or equipment stored on the job site is stored at the Contractor's risk. Any damage sustained of whatever nature shall be repaired to the Engineer's satisfaction at no expense to the Owner. Stored electrical equipment is to be protected from the elements and shall have space heaters energized.

C. Contractor shall not store unnecessary materials or equipment on the job site and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.

D. Contractor shall observe all regulatory signs for loadings on structures, fire safety, and smoking areas.

E. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

3.03 MANUFACTURER’S FIELD SERVICES

A. The Contractor shall arrange for a qualified Technical Representative from each manufacturer or supplier of equipment who is regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of the specified equipment. Qualification of the Technical Representative shall be appropriate to the type of equipment furnished and subject to the approval of the Engineer and the Owner. Where equipment furnished has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment. When necessary, the Contractor shall schedule multiple Technical Representatives to be present at the same time for the purpose of coordinating the operation of multiple pieces of related equipment.

B. For each site visit, the Technical Representative shall submit jointly to the Owner, the Engineer, and the Contractor a complete signed report of the results of his inspection, operation, adjustments, and testing. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified.

C. The manufacturer's Technical Representative shall provide the following services.

1. Installation: The Technical Representative shall inspect the installed equipment to verify that installation is in accordance with the manufacturer's requirements. Where required by individual equipment specifications, the Technical Representative shall also supervise the installation of the equipment.

2. Testing: After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Technical Representative shall inspect, operate, test, and adjust the equipment as required to prove that the equipment is in proper condition for satisfactory operation under the conditions specified. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for startup and that nothing in the installation will render the manufacturer's warranty null and void. The report shall include date of final acceptance field test, as well as a listing of all persons present during tests.

3. Startup: The Technical Representative shall start up the equipment for actual service with the help of the Contractor. In the event that equipment or installation problems are experienced, the Contractor and the representative shall provide the necessary services until the equipment is operating satisfactorily and performing according to the specifications at no additional cost to the Owner. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

4. Training: The Technical Representative shall instruct the Owner's operating personnel in correct operation and maintenance procedures. The instruction shall demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment. Such instruction shall be scheduled at a time arranged with the Owner at least 2 weeks in advance of the training and shall be provided while the respective Technical Representative's equipment is fully operational. The Contractor shall have submitted, and had accepted, the O&M Manuals prior to commencement of training. Training shall be provided to three separate shifts of the Owner's personnel between the hours of 8:00 A.M. and 6:00 P.M. as necessary. The Contractor shall provide professional video taping of all training sessions. Completed, labeled tapes shall be provided to the Owner for each type of training session.

5. Services after Startup: Where required by the individual equipment specifications, the Technical Representative shall return to the project site thirty (30) days after the start up date to review the equipment performance, correct any equipment problems, and conduct operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of Technical Representative prior to and during equipment startup. At this time, if there are no equipment problems, each manufacturer shall certify to the Owner in

writing that his equipment is fully operational and capable of meeting operating requirements. If the equipment is operating incorrectly, the Technical Representative will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful thirty (30) days operating period.

D. Services of the Technical Representative will require a minimum of two (2) site visits, one for installation and testing and one for startup and training, and will be for the minimum number of days recommended by the manufacturer and approved by the Engineer but will not be less than the number of days specified in individual equipment sections.

E. The Contract amount shall include the cost of furnishing the Technical Representative for the minimum number of days specified, and any additional time required to achieve successful installation and operation. The times specified for services by the Technical Representative in the equipment Specifications are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

F. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test or Owner training session.

G. The Technical Representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

3.04 INSTALLATION

A. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation. Equipment shall be installed strictly in accordance with recommendations of the manufacturer. A copy of all installation instructions shall be furnished the Engineer's field representative one week prior to installation.

B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.

C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.

D. All equipment sections and loose items shall be match-marked prior to shipping.

E. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the manufacturer's qualified mechanic, millwright, or machinist, to align the pump and motor prior to making piping connections or anchoring the pump base. Alignment shall be as specified herein.

F. The Contractor shall furnish oil and grease for initial operation and testing. The manufacturer and grades of oil and grease shall be in accordance with the recommendations of the equipment manufacturer.

3.05 ALIGNMENT

A. Set equipment to dimensions shown on drawings. Dimensions shall be accurate to +/- 1/16 inch unless otherwise noted on the drawings. Wedges shall not be used for leveling, aligning, or supporting equipment.

B. General Equipment Leveling: Non-rotating equipment shall be set level to +/- 1/16 inch per 10 foot length (.005 inch per foot) unless otherwise noted on the drawings. Shims shall be used unless equipment is furnished with leveling feet. Set shims flush with equipment baseplate edges. When grouting is required, equipment shall be shimmed to allow a minimum of one inch grout thickness. Grout shall cover shims at least 3 inches. Final level check shall be held for inspection and approval by Engineer before proceeding.

C. Grouting

1. Fill anchor bolt holes or sleeves with grout, after bolt alignment is proven, and prior to placing grout under equipment bases.

2. Surface Preparation. Roughen surface by chipping, removing laitance, and unsound concrete. Clean area of all foreign material such as oil, grease, and scale. Saturate area with water at least 4 hours prior to grouting, removing excess water ponds.

3. Application. Place grout after the equipment base has been set and its alignment and level have been approved. Form around the base, mix grout, and place in accordance with the grout manufacturers published instructions. Eliminate all air or water pockets beneath the base using a drag chain or rope.

4. Finishing. Point the edges of the grout to form a smooth 45 degree slope.

5. After grout has cured (not before 3 days after placement) paint exposed surfaces of grout with shellac.

6. Level Verification. After grout has cured, and immediately prior to drive alignment, recheck equipment for level and plumb. Re-level and square as necessary. Hold final checks for inspection and approval by Engineer.

D. Inspect for and remove all machining burrs or thread pulls in female holes on mating surfaces of mounting frame and machine feet.

E. Inspect and clean equipment mounting base pads, feet, and frames to remove all grease, rust, paint and dirt.

F. Assembled equipment shafts shall be set level to .0015 inches per foot of shaft length (+/- .0005 inches) up to a maximum of 0.015 inches for any length shaft unless the manufacturers requirements are more stringent or unless otherwise noted in the equipment specifications. Use the machined surfaces on which the equipment sets for the base/mounting frame leveling plane. Use the machined shaft surface for equipment leveling plane.

G. Sprocket and Sheave Alignment. Check shaft mounted components for face runout and eccentricity (outside diameter) runout by magnetically mounting a dial indicator on a stationary base and indicating over 360 degrees on a continuous machined surface at the outside diameter of the component. Maximum allowable total indicated face runout and eccentricity for sprockets and sheaves will be per ANSI Standard B29.1-1975.

H. Belt tensioning. Set drive belt tension to manufacturer's specification for the belt type. Recheck alignment after drive tensioning.

I. Thermal/Mechanical Growth. Thermal/mechanical growth corrections for driver and driven machines will be used in vertical and horizontal alignment where applicable. The equipment manufacturer will determine thermal/mechanical growth applicability for any machine and provide the correction offsets to be used.

J. Rotating Shaft Alignment

1. Fixtures will be set up on the driver and driven machine, machines shaft surfaces. Machined coupling hubs may be used only if there is no clearance to mount fixtures directly on the shafts.

2. Primary alignment method for direct drive machines is when coupled. Uncoupled alignment will be used only when approved by the Engineer.

3. Account for possible coupling flex by always rotating coupled machines in the same direction during alignment.

4. Uncoupled machines must be connected so that both shafts turn together without relative motion during alignment.

5. Indicator bar sag will be measured and included for each reverse indicator alignment setup.

6. Reverse Dial Indicator. The final maximum allowable misalignment: vertical and horizontal from the desired targets of .000 inches (for a non-thermal growth machine) or from the given target readings (for a thermal growth machine) must meet BOTH of the following conditions simultaneously: 1/2 the final total indicator reading at each indicator will be no more than shown in the table below AND the final remaining correction at each machine foot be no more than .001 inches of required movement.

Machine Speed (RPM)	Total Misalignment* (inches)
Up to 1800	.002
1800 and greater	.001

* 1/2 indicator reading

3.06 FIELD TESTING

A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions. Provide all necessary calibrated instruments to execute performance tests. Submit report certified by the manufacturer’s representative.

B. Preliminary Field Tests, Yellow Tag

1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall:

   a. Verify that the equipment is free from defects.

   b. Check for alignment as specified herein.

   c. Check for direction of rotation.

   d. Check motor for no load current draw.

2. Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.

3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or his assigned representative and attached to the equipment. The tag shall not be removed.

4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

C. Final Field Tests, Blue Tag

1. Upon completion of the above, and at a time approved by the Engineer, the equipment will be tested by operating it as a unit with all related piping, ducting, electrical and controls, and other ancillary facilities.

2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his assigned representative and the Owner or his assigned representative.

3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Operating field tests shall consist of the following:

   a. Check equipment for excessive vibration and noise as specified herein.

   b. Check motor current draw under load conditions. The rated motor nameplate current shall not be exceeded.

   c. Recheck alignment with dial indicators where applicable, after unit has run under load for a minimum of 24 hours.

D. In addition to the above described field tests, any other tests specifically required by Section 11100S, Pumps-General, the individual equipment Specifications, or by the manufacturer shall be performed.

E. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.

F. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.

G. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.

H. All costs in connection with field testing of equipment such as lubricants, temporary instruments, labor, equipment, etc., shall be borne by the Contractor. Power, fuel, chemicals, water, etc. normally consumed by specific equipment shall be supplied by the Owner unless otherwise specified in the individual equipment specifications.

I. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

J. Field testing of electric motors shall be in accordance with Section 15170S, Electric Motors; Section 15171S, Medium Voltage Electric Motors, and Section 16000S, Basic Electrical Requirements.

3.07 VIBRATION TESTING

A. Unless specified otherwise in the detailed equipment specifications, each pump, blower, compressor, motor or similar item of stationary rotating equipment having a rated power in excess of 40HP shall be tested after installation for acceptable vibration levels.

B. Vibration testing shall be performed by an experienced factory-trained and authorized third-party analysis expert (not a sales representative) retained by the Contractor and approved by the Engineer. Each unit or pump system shall be tested separately without duplicate equipment running. All field testing shall be done in the presence of the Engineer. The Engineer shall be furnished with four (4) certified copies of vibration test data for each test performed.

C. For systems with variable speed drives, tests shall be conducted at various speeds between maximum and minimum. For systems with two-speed drives, tests shall be conducted at both speeds. For systems with constant-speed drive, tests shall be conducted under various loading conditions as determined by the Engineer.

D. All field vibration tests shall be performed with the equipment operating on the product for which it is intended, or a substitute acceptable to the Engineer.

E. The term displacement, as used herein, shall mean total peak-to-peak movement of vibrating equipment, in mils; velocity or speed of the vibration cycle, measured in G's. Displacement and velocity shall be measured by suitable equipment equal to IRD Mechanalysis, Bentley, Nevada.

E. Frequency of vibration, in cycles per minute (cpm), shall be determined when vibration exceeds specified levels or as otherwise necessary. Vibration shall be measured on the bearing housing, unless other locations are deemed necessary by the vibration analysis expert and Engineer.

F. For all equipment tested, vibration shall be checked in the radial and axial directions. Unless otherwise specified elsewhere, axial vibration shall not exceed 0.1 in/sec; and radial vibration shall not exceed 0.2 in/sec. For pumps radial vibration shall not exceed that permitted by the Hydraulic Institute Standards except that, at vibration frequencies in excess of 8,000 cpm, the velocity shall not exceed 0.2 in/sec.

G. Copies of test results shall be submitted to the Engineer for review. Should the vibration field test results exceed shop test results, the manufacturer's recommendations, or the limits specified herein, the Contractor shall correct the deficiencies within thirty (30) days. After corrections have been completed, the vibration testing shall be re-run and the results re-submitted to the Engineer for review.

H. Noise or vibration in any rotating equipment which the Engineer judges to be excessive or damaging, shall be cause for rejection.

3.08 FAILURE OF EQUIPMENT TO PERFORM

A. Any defects in the equipment, or failure to meet the guarantees or performance requirements of the Specifications shall be promptly corrected by the Contractor by replacements or otherwise.

B. If the Contractor fails to make these corrections, or if the improved equipment shall fail again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at the Contractor's expense.

C. The Contractor shall then obtain specified equipment to meet the contract requirements or upon mutual agreement with the Owner, adjust the contract price to reflect not supplying the specific equipment item.

D. In case the Owner rejects said equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him for said rejected equipment on progress certificates or otherwise on account of the lump sum prices herein specified.

E. Upon receipt of said sums of money, the Owner will execute and deliver to the Contractor a bill of sale of all his rights, title, and interest in and to said rejected equipment; provided, however, that said equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected.

F. Said bill of sale shall not abrogate Owner's right to recover damages for delays, losses, or other conditions arising out of the basic contract.

3.09 PAINTING

A. All surface preparation, shop painting, field repairs, finish painting, and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900S, Painting.

B. All shop coatings shall be compatible with proposed field coatings.

C. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.

D. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.10 WELDING

A. The Equipment Manufacturer's shop welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirement of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.

B. The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.

C. The Contractor shall perform all field welding in conformance with the information shown on the Equipment Manufacturer's drawings regarding location, type, size, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society, and special conditions, as shown by notes and details.

- END OF SECTION -

SECTION 11100S

PUMPS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall furnish and the Contractor install, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.

B. All pumping equipment shall be provided in accordance with the requirements of Section 11000S, Equipment General Provisions.

C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.

D. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.

1.02 SHOP DRAWINGS

A. Shop Drawings shall include the following information in addition to the requirements of Section 01302S, Submittals and Section 11000S, Equipment General Provisions.

1. Details of shaft sealing system

2. Pump performance curves at rated speed and reduced speed (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, NPSH required, and minimum submergence. Curves shall include limits (minimum and maximum flows) for stable operation without cavitation, overheating, recirculation, or excessive vibration.

3. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, and anchor bolt locations and forces.

4. Foundry certificates and results of Brinnell hardness testing showing compliance to ASTM A 532 (where required in the individual pump specifications).

5. Submersible pump submittals shall also include:

a. Product data sheets for power and control cables and length of cables.
b. Details on pump guide rail system and mounting requirements.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. All materials employed in the pumping equipment shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.

2. Bronze pump impellers shall conform to ASTM B 584, “G” bronze.

3. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.

B. Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.

C. Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.02 APPURTENANCES

A. Pressure Gauges

1. The Contractor shall furnish and install pressure gauges on the suction and discharge of each pump, except wet-pit submersible pumps and vertical turbine pumps.

2. The Contractor shall furnish and install pressure gauges on the discharge piping of each wet-pit submersible pump and vertical turbine pump in the locations shown on the Drawings or as directed by the Engineer.

3. Suction gauges shall be of the single scale compound type to indicate both pressure and vacuum. Each suction gauge shall be graduated in feet of water over the span of 34 feet below and above zero.

4. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head or to a minimum of 30% above the maximum operation pressure, whichever is greater. Graduation shall be in feet of water.

5. All gauges shall be supplied by one manufacturer and shall be as specified in Section 17650S, Pressure Gauges.

6. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 17698S, Instrumentation and Control Accessories.

B. Flexible couplings for direct driven pumps shall be as manufactured by Falk, Dodge, Woods Corp., or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.

2.02 ELECTRICAL REQUIREMENTS

A. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Engineer.

B. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between pump supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16S and shall be as specified in Section 16495, Variable Frequency Drive Systems.

C. Motor starters and controls shall be furnished and installed under Division 16S and Division 17S unless otherwise specified in the individual pump specifications.

2.03 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of Section 11000S, Equipment General Provisions, nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency at the primary design point.

<u>PART 3 -- EXECUTION</u>

3.01 INSTALLATION

A. <u>Drains</u>: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with galvanized steel pipe or copper tube, properly supported with brackets.

B. <u>Solenoid Valves:</u> Where required, the pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

3.02 SHOP TESTING

A. Shop tests shall be performed in accordance with Section 11000S and, except where stated otherwise herein, shall be conducted in accordance with the latest version of Hydraulic Institute Standard 14.6, Hydraulic Performance Acceptance Tests.

B. Pump testing shall be witnessed by the Owner/Engineer where specified in the individual pump specifications. The testing procedure shall be submitted to the Engineer for review before scheduling the testing. The Engineer shall be given at least 2 weeks advanced notice of the scheduled testing date.

C. Certified test curves for shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications. Certified tests will not be required for submersible sump pumps (as specified in Sections 11130S) with motors less than 5 hp.

D. Pumps shall be within the tolerances specified for Acceptance Grade 1U, in accordance with the latest version of Hydraulic Institute Standards 14.6.

E. For wet pit submersible pumps and vertical turbine pumps, all tests shall be run at minimum pump submergence specified in the individual pump specifications.

F. Where required in the individual pump specifications, each individual casting shall be Brinnell tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E-10. Results shall be certified by a registered professional ENGINEER. Test results shall verify the satisfaction of the required Brinnell hardness of the finished product as specified in respective subsections.

3.03 FIELD TESTING

A. Field tests shall be performed in accordance with in Section 11000S and additionally as specified below and in the individual pump specifications.

B. Final acceptance tests shall demonstrate the following:

1. The pumps have been properly installed and are in proper alignment.

2. The pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.

3. The pumps can meet the specified operating conditions. All pumps shall be checked at maximum speed for a minimum of four points on the pump curve for capacity, head, and amperage. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing.

- END OF SECTION -

SECTION 11130S

SUBMERSIBLE NON-CLOG PUMPS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall furnish and Contractor install submersible non-clog pumps at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the requirements of Section 11000S, Equipment General Provisions and Section 11100S, Pumps - General.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. The pumps shall be capable of meeting the performance requirements specified by the Offeror in Section 3.4 of the RFP.

1.03 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01302S, Submittals; and Section 11000S, Equipment General Provisions:

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Each pump shall be a submersible, non-clog, centrifugal pump, as manufactured by ABS, Fairbanks Nijhuis, Flygt, KSB, or equal.

2.02 MATERIALS

A. The pump and all related equipment shall be designed for the wastewater applications specified herein and shall be suitable for continuous or intermittent operation. The pump shall be bottom suction, side discharge construction and shall be supplied with a foot mounted discharge connection elbow and integral sliding rail removal system of the pump manufacturer's design matched to the pumps being supplied.

B. The lifting cover, stator housing, and volute casing shall be close grained cast iron conforming to ASTM A48-Class 30, 35, or 40. Ductile iron pump volute shall be furnished if recommended by pump manufacturer for specified pressure rating. All exposed nuts, bolts, washers, and other fastening devices shall be AISI type 316 stainless steel.

C. Casing shall be a smooth surface devoid of blowholes, pits, burrs, or other irregularities. The casing shall have a suction cover, which can be easily removed for easy access to the impeller. All non-stainless steel metal surfaces coming in contact with the pumped media shall be protected by a factory applied spray coating of Supplier’s modified acrylic primer and finish. The volute shall be single piece, non-concentric design and shall have smooth fluid passages large enough at all points to pass any size solids which can pass through the impeller.

D. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile or Viton rubber 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 the requirement of a specific torque limit. Secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall not be acceptable.

E. The pump impeller shall be hard alloy gray cast iron conforming to ASTM A-48 Class 30, 35, or 40. Impellers shall be dynamically balanced, closed non-clogging design with multiple vanes. The impeller shall be capable of handling solids of specified sphere size, fibrous materials, heavy sludge, and other matter found in normal wastewater applications. The impeller shall be mechanically secured to the motor shaft per manufacturer's recommendations utilizing machined stainless steel components. Adhesive or friction-type fits are not acceptable. Impeller shall be coated with the same system applied to the interior of the casing.

F. A wear ring system shall provide efficient sealing between the volute and impeller. Casing and impeller wear ring shall be of stainless steel construction. Supplier shall submit AISI grades of stainless steel proposed for the wear rings. Rings shall be drive fitted to the volute inlet and heat-shrink fitted to the impeller.

G. Shafting shall be constructed of AISI 329 stainless steel or 400 Series stainless steel for the pump and motor, sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such a design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be suitably heat-treated, turned, ground, and polished over its entire length.

H. Shaft Seals

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies of high-pressure design. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. Seal lubricant shall be FDA Approved, nontoxic.

2. The lower, primary seal unit, located between the pump and the lubricant chamber shall contain one stationary and one positively driven rotating, industrial duty, corrosion resistant, seal rings (Tungsten carbide/Tungsten carbide, Silicon carbide/Silicon carbide or Tungsten carbide/Silicon carbide). The lower seal shall be independent of the impeller hub.

3. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, chamber shall contain one stationary and one positively driven rotating, industrial duty, corrosion resistant, seal rings (ceramic/carbon or carbo/Ni-resist).

4. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal. The seal system shall not be damaged when run dry. No external source of seal cooling or lubrication water shall be required.

5. The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. Cartridge type systems will not be acceptable. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

I. The pump shaft shall rotate on at least two (2) heavy duty permanently lubricated bearings. Bearings shall be designed to carry all radial and axial thrust loads and shall have a minimum AFBMA B-10 life of 100,000 hours at all points along the usable portion of the pump curve at maximum pump speed.

J. Gauge taps shall be provided on the discharge piping of the vertical submersible pumps in a location as directed by the Engineer. Gauge taps shall be threaded corporation stops, conforming to the requirements of Section 15000S, Basic Mechanical Requirements. Gauges shall be as specified in Section 17650S, Pressure Gauges.

K. The Slide Rail Mounting System shall be as shown on the Contract Drawings and as specified herein.

1. A rail system shall be provided and installed for each pump. The pump shall be easily removed from the wetpit for inspection or service without entering the pit or disconnecting piping.

2. The pump shall be provided with a foot mounted discharge connection elbow constructed of cast iron conforming to ASTM A48-Class 30 or 35, permanently installed in the wet well along with the discharge piping. The discharge connection elbow shall be constructed with a 125 lb. ANSI standard flat faced flange. The pump shall be automatically connected to the discharge connection elbow when lowered into place, and shall be easily removed for inspection or service. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple downward motion of the pump.

3. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by the guide bar(s) and pressed tightly against the discharge connection elbow to provide positive sealing under all conditions.

4. The entire sliding rail system shall be designed to safely withstand all stresses imposed thereon by vibration, torque, shock and all possible direct and eccentric loads. No portion of the pump shall bear directly on the floor of the sump.

5. Lower guide bar holders shall be integral with the discharge connection. Guide bars shall be of at least standard weight 316 stainless steel pipe of a conservative size

adequate for its intended use. The guide bars shall not support any portion of the weight of the pump.

6. All anchor bolts, lifting bolts, eye lugs and lifting cable, etc. necessary for a complete installation and maintenance of the pump shall be constructed of Type 316 stainless steel and shall be adequately designed for its intended use.

L. All anchor bolts, lifting bolts, eye lugs, etc. necessary for complete installation and maintenance of the pump shall be furnished by Supplier and constructed of Type 316 stainless steel and shall be adequately designed for its intended use.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

A. The pump manufacturer shall provide the power and control cables between the pump and the local disconnect switch, junction box, or control panel (see Drawings) and shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All pumps for the same pumping application shall be provided with the same length of cable. No splices shall be allowed unless specifically indicated on the Drawings. Cables shall be PVC or oil resistant cloroprene rubber jacketed type SPC cable suitable for submersible pump applications, shall be sized according to NEC and ICEA standards, and shall meet with MSHA approval. Stainless steel strain relief connectors shall be furnished for all cables.

B. Cable Entry Water Seal

1. The cable entry water seal design shall insure a watertight and submersible seal without specific torque requirements. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate gaining access through the pump top. The junction chamber containing the terminal board shall be sealed from the motor by an elastomer compression seal O-ring. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to the terminal board and thus perfectly leak proof. Each pump shall be equipped with separate terminal board that totally isolates the incoming power supply from the pump motor.

2. An acceptable alternate cable entry seal shall include cable leads shall enter at the top of the motor and shall allow the cable-to-motor connection to be accomplished in the field without soldering. All power and control lead wires shall be double sealed as they enter the motor in such a manner that cable-wicking will not occur. This sealing system shall consist of a rubber grommet followed by epoxy that is high in adhesive qualities and has a low coefficient of expansion. Each conductor shall have a small section of insulation removed to establish a window area of bare wire and each wire shall be untwisted and surrounded by epoxy potting material. A cable strain relief mechanism shall be an integral part of the sealing system. The cable sealing system shall be capable of withstanding an external pressure test of 1,200 psi as well as a cable assembly pull test as required by Underwriters Laboratories.

Power and control leads shall be terminated on a sealed terminal board. The terminal board and its bronze lugs shall be O-ring sealed.

A. Electrical Requirements

	Pumps
Motors	
Rating	460V, 3 ph, 60 Hz
Maximum Horsepower	Per RFP
Maximum Speed, rpm	Per RFP
Insulation	Class H
Explosion Proof	No
Inverter Duty	Yes
Service Factor	1.0
Motor Winding Temperature Switches	Yes
RTDs	No
Cooling Jacket	Per manufacturer requirements for operation at Low Water Level

D. The pump motor shall be a squirrel-cage induction type, housed in a watertight chamber. The stator winding and stator leads shall be moisture resistant. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be allowed.

E. The motor shall be guaranteed for continuous unsubmerged duty, capable of sustaining a minimum of five (5) starts per hour without overheating.

F. The motor shall be provided with pre-lubricated radial and thrust bearings which are designed to carry the entire load which may be imposed upon it under all operating conditions.

G. All motors shall be of nationally known manufacture, shall be housed in enclosures specifically designed for submersible pump application.

H. Moisture detector probes shall be provided in the oil-seal chamber. The pump manufacturer shall provide a moisture detection relay compatible with the probes. The relay shall be installed in the location shown on the Drawings.

I. Biomass Separation System Pumps shall be provided with insulated motor bearings and the pump manufacturer shall provide an external motor grounding system to protect motor bearings from induced currents.

2.04 LOCAL CONTROL PANEL

A. The pump manufacturer shall provide local control panels (LCP) and electrical appurtenances for the Microscreen Feed Pumps. The local control panels shall be shall be designed to receive power from a single 480VAC, 3-phase source.

B. Control Panel

1. Control Panel for the pump station shall be shipped to the site, completely pre-wired, pre-assembled and ready for service. The control panel shall be NEMA-4X stainless steel with hinged door and lockable handle. Panel shall have a back mounting panel and a front inside hinged panel to make the control panel "dead-front" when outside door is open. Refer to electrical contract drawings for additional requirements. The panel shall be UL 508 labeled. Panel components shall be Square D, Cutler-Hammer, or GE; unless stated otherwise. The panel shall contain the following:

   a) Main panel circuit breaker type with lockable disconnect switch and an externally operated handle

   b) NEMA 4X button lights with LED lamps, transformer type, labeled "Pump Run" and “Pump Fail” mounted on door - for each pump.

B. Each tank Biomass Retention System station LCP shall include the following panel mounted pilot devices, as a minimum:

   1. START pushbutton – one per pump
   2. STOP pushbutton – one per pump
   3. RUN indicating light – one per pump
   4. FAIL indicating light (Motor Overload) – one per pump

2.05 SPARE PARTS

A. Spare parts shall be provided in accordance with Section 11000S, Equipment General Provisions and shall include the following for each series of pumps

One (1) - set of lower and upper wearing rings
One (1) - set of motor and pump bearings
One (1) - complete mechanical seal assembly (upper and lower)
Two (2) - complete set of gaskets and O-ring seals

PART 3 -- EXECUTION

3.01 MANUFACTURER’S FIELD SERVICES

A. Manufacturer’s field services shall be in accordance with Specification 11000S, Equipment General Provisions, and as specified herein.

B. Assist Contractor during installation to include observation, guidance, and instruction of the manufacturer’s recommended procedures for assembly, erection, installation and application.

C. Inspect, check, and adjust equipment as required for equipment to function as guaranteed.

D. At a minimum, the number of days indicated below shall be provided on an 8-hour-day on-site basis and shall be in addition to travel time. The number of days at the site shall be increased as necessary, without change to the proposal price or schedule, to accomplish the Work of this Section. Minimum service durations by the manufacturer are as follows:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Testing	1	1
Startup and Training	1	2
Services after Startup	1	1

E. Training shall be provided by the manufacturer in accordance with Section 01652S, Project Commissioning.

F. A written report covering the manufacturer’s representative's findings at each visit and at installation approval shall be submitted to the Engineer. The report shall cover all inspections and shall outline in detail any deficiencies noted and all corrective measures taken or recommended.

3.02 TESTING

A. Testing shall be as specified herein, and in accordance with Section 11000S – Equipment General Provisions, Section 11100S, Pumps – General, Section 11200S – Sidestream Deammonification System, and Section 01652S – Project Commissioning.

B. Shop testing shall be in accordance with Section 11000S and with the following additional requirements:

1. Impeller, motor rating and electrical connections shall be checked.

2. A motor and cable insulation test for moisture content or defective insulation shall be made.

3. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

4. The pump shall be run for 30 minutes submerged, a minimum of six (6) ft. under water.

5. After the run-dry test, the insulation test shall be performed again.

6. After the run-dry test, the pump shall be run continuously unsubmerged for 2 hours under full load with no damage to the motor. During this test, the pump shall demonstrate compliance with the specified performance for flow, head, and horsepower and shall experience a heat rise of not greater than 45°C (80°F) above ambient temperature.

- END OF SECTION -

SECTION 11185S

POSITIVE DISPLACEMENT BLOWER PACKAGES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall furnish and Contractor install, test, adjust, and place in satisfactory operation two (2) heavy duty positive displacement blower systems for installation indoors in acoustical enclosures complete with all accessories including motors, steel bases, inlet filters, inlet silencers, discharge silencers, relief valves, check valves, flexible connectors, V-belt drive, guards, vibration isolation, and other components required for a complete and operable blower system as shown on the Drawings and as specified herein. The Contractor shall provide a variable frequency drive for each of the blower packages furnished under Division 16S – Electrical.

B. Equipment and manufacturer's services shall be provided in accordance with the requirements of Section 11000S – Equipment General Provisions.

C. Blowers shall be as furnished by Aerzen or Kaeser. No alternative manufacturers will be accepted.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1S – General Requirements

B. Division 5S – Metals

C. Section 09900S – Painting

D. Section 11000S – Equipment General Provisions

E. Section 15101S – Butterfly Valves

F. Section 15170S – Low Voltage Electric Motors

G. Section 16495S – Variable Frequency Drive System

H. Division 17S – Control and Information Systems

1.03 SUBMITTALS

A. In addition to the submittal requirements specified in Section 01302S - Submittals and Section 11000S - Equipment General Provisions, submit the following:

1. Support locations and loads that will be transmitted to bases and foundations. Weights of all system components and the total weight of the operating blowers.

2. Complete electrical field termination drawings.

3. Electrical equipment product data sheets.

4. Overall equipment layout and piping interconnection drawings.

5. Copies of shop test reports.

6. Field test results.

7. Blower performance curves including capacity/pressure/speed curves and horsepower/pressure/speed curves at standard conditions of 14.7 psia inlet pressure, 68°F inlet temperature, and 36% relative humidity.

8. Blower performance curves including capacity/pressure/speed curves and horsepower/pressure/speed curves at the Design Inlet Conditions specified in Paragraph 2.02.

B. Furnish Operation and Maintenance manuals, shop drawings and other material required as specified in Section 01302S and Section 11000S.

C. The Offeror shall submit a complete list of additional spare parts, beyond those specified herein, which the manufacturer recommends being kept on hand and as specified in Section 11000S.

1.04 QUALITY ASSURANCE

A. The materials covered by the Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable Manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed and operated per the Manufacturer's recommendations.

B. The blower package shall be furnished by the manufacturer of the blower itself to ensure single source responsibility for blower performance and compatibility of associated accessories. Blower packages that utilize blowers not specifically manufactured by the blower package suppliers themselves are not acceptable.

C. The Manufacturer shall have a minimum of ten years of experience producing similar positive displacement blowers for the North American municipal wastewater treatment industry with similar capacity, motor horsepower, and discharge pressure design criteria specified herein, as a minimum. The Manufacturer shall be able to show evidence of at least ten distinct installations in satisfactory operation for at least three years, and at least five distinct U.S. municipal wastewater treatment installations of the size and model of blower proposed in satisfactory operation for at least two years.

D. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these specifications. All parts of duplicate machines shall be interchangeable without modification. The construction of the blower shall be such that the blower will not be damaged during continuous operation and will not have undue vibration within the blower's operational limits. The design and construction of the blower shall not cause any unbalanced floor loadings.

E. The Contractor shall protect blower system components at the project site and during installation. The Contractor shall be responsible for scheduling and coordinating delivery of the blower with the Offeror to minimize the time that blower is stored on-site. The Contractor shall be responsible for any additional cost incurred for storage of the blower.

1.05 OFFEROR'S RESPONSIBILITY

A. The Offeror, through the manufacturer, shall provide the services of qualified service persons with at least five (5) years of experience who are regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of positive displacement blower systems. The service persons shall:

1. Check installation.

2. Assist the Offeror in conducting field tests and preparing a written report as specified below.

3. Witness and check start-up of the system.

4. Assist the Offeror in making adjustments and modifications as necessary to optimize operation of system components.

5. Troubleshoot and correct any mechanical or control problems that are noted during tests and start-up.

6. Submit written certification that the systems have been properly installed, tested, and adjusted, and that all controls and protective devices operate properly, including date of final acceptance test, as well as a listing of all persons present during the tests.

7. Investigate and supervise correction of any operating problems that may arise up to the end of the guarantee period of the equipment.

8. Instruct Owner personnel in the operation and maintenance of the equipment.

B. The services of a qualified manufacturer's technical representative shall be provided at no additional cost to the Owner for a period of not less than one (1) day for each blower, for a total of two (2) days at minimum, travel time excluded. Manufacturer's technical representative shall assistance during installation, commissioning, and training of Owner's personnel for equipment operation.

C. Any additional time required to achieve successful installation and operation shall be at the expense of the Manufacturer.

1.06 WARRANTY AND GUARANTEE

A. Warranty and Guarantee shall be as specified in Section 11000S, Sidestream Deammonification System. The warranty period shall be for two (2) years from startup.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The blower packages shall be Delta Generation 5 as manufactured by Aerzen or Omega Plus as manufactured by Kaeser.

B. The layout and design of the aeration blower system including blower equipment pads, blower discharge piping and supports, blower ventilation fans, HVAC systems, electrical power supply, conduits, cables, instrumentation, and controls in the contract drawings and specifications are based on equipment manufactured by Aerzen. Any design modifications or additions including but not limited to concrete, piping, structural supports, HVAC systems, electrical systems, instrumentation and controls, resulting from the use of equipment from other manufacturers (named or unnamed) shall be the sole responsibility of the Offeror and shall be provided by the Offeror at no additional cost to the Owner. Any redesign for substitute equipment shall be submitted for the Engineer's review prior to fabrication or installation.

2.02 PERFORMANCE REQUIREMENTS

A. The blowers shall be capable of meeting the performance requirements specified by the Offeror in Section 3.4 of the RFP based on the operating conditions below. The blowers shall be capable of providing the specified blower capacity at the design discharge pressure at the package discharge flange at the design inlet conditions specified below. The Offeror shall specify the discharge pressure in the response to the RFP as the required pressure at the blower package discharge flange. The Offeror shall specify the ICFM in the response to the RFP as the required airflow at the inlet to the package and excludes any internal blower package losses (inlet filter, inlet piping, silencer, etc.). The blower package manufacturer shall account for all inlet losses (inlet filter, inlet piping, silencer, etc.) and all discharge losses (silencer, check valve, etc.) within the blower package in determining the total differential pressure to be provided by the blower.

Site Ambient Conditions	
Elevation, feet above MSL	251
Barometric Pressure, psia	14.4
Temperature Range, °F	0 to 104
Relative Humidity Range, %	0 to 100
Design Inlet Conditions	
Minimum Inlet Pressure, psia	14.4
Maximum Inlet Temperature, °F	100
Design Inlet Relative Humidity, %	80
Blower Capacity Requirements at Design Inlet	
Number of Blowers	2 (1 duty, 1 stand-by)
Acoustic Enclosure Type	Close Fitting

2.03 BLOWER CONSTRUCTION

A. A welded steel fabricated base or combination base frame and discharge silencer shall be provided for mounting the blower, electric drive and driver base. The base shall be of a rigid box section shape. The box section shall be properly stiffened and present large bearing areas for carrying the load on the foundation. The base shall be rigid to prevent deflection during start-up and normal operation that would affect alignment. Resilient isolation pads shall be provided between the concrete mounting or bottom of the blower enclosure and the base of the blower unit. Positioning pins and jackbolts shall be provided to facilitate motor alignment when motor is coupled directly to blower. The base shall support the blower and a pivoting motor base. The motor shall be mounted on the pivoting base. The weight of the motor shall provide 100% maintenance free automatic belt tensioning. Installation shall conform to recommendations of the blower and V-belt component manufacturers including motor, V-belt drive, guard, controls, and all necessary items. V-belts shall be of the stretch resistant type with a fully automatic belt tensioning mechanism.

B. The blower casing shall be one piece with separate headplates, and shall be made of close-grained cast iron suitably ribbed to prevent distortion under the specified operating conditions. The casing shall incorporate a proven means of pulsation cancellation such that the sound pressure level measured 3 feet from the front and side panels of the blower package does not exceed the value specified in Paragraph 2.02. The vibration level as measured at the blower casing, in the X/Y planes of the bearings, shall not exceed 0.55-inch/sec RMS when operating at the specified maximum operating pressure and speed in the actual blower package.

C. Shafts and rotors shall be forged or cast from a single piece of steel. Alternatively the lobe and shaft shall be of one piece construction that is machined together. The single lobe shall be of the straight, tri-lobe involute type and shall operate without rubber or liquid seals or lubrication and shall be positively timed by a pair of accurately machine heat-treated alloy steel, helical tooth or straight cut timing gears. The timing gears shall be mounted on the lobe shafts with a press fit and keyed or mounted by hydraulic expansion onto the blower shafts with a tapered interference fit. Timing gears shall either be straight cut and beveled or one gear shall be equipped with a hub and a gear to facilitate accurate and easy timing. Each lobe/shaft shall be supported by cylindrical roller bearings sized for a minimum of 100,000 hours B-10 life met through normal operation with average and peak conditions.

D. The lube oil system shall be supplied with a sight glass and ample oil reservoir capacity. Piston ring oil seal shall be provided at each bearing, designed to prevent lubricant from leaking into the air stream. Rotary piston ring shaft seals shall be provided at the point where the shaft passes through the head plate (air seal). A total of 16 piston ring seals shall be provided for each blower. Further provision shall be made to vent lubricant to the impeller side of the oil seal to atmosphere to eliminate any possible carryover of lubricant into the air stream. Lip seals inside the blower shall not be acceptable. Lip seal is allowed at the drive shaft only, complete with wear sleeve.

E. The timing gears and the bearings shall be splash oil lubricated from oil slingers mounted on the driven or non-driven shaft and dipping in oil. Grease lubricated bearings shall not be acceptable. Each bearing shall be equipped with an oil deflector disc if necessary to further reduce oil leaks.

F. Blower package shall be designed to allow ease of access to oil drain plugs. Drains shall be piped to the front of the enclosure to allow for easy access. Blower package shall have a single oil drain and single oil fill connection with oil level sight glass mounted on the exterior of the sound enclosure.

2.04 BLOWER ACCESSORIES

A. Each blower shall be supplied with one combination inlet filter/silencer. The inlet filter/silencer shall be mounted directly to the inlet flange of the blower. The filter element shall be washable by maintenance personnel as a preventative maintenance procedure.

B. If a combination inlet filter/silencer is not proposed by the manufacturer, then each blower may be supplied with one inlet silencer and one inlet filter. The inlet silencer shall be a combination chamber and absorptive design for maximum sound attenuation. Inlet silencer performance losses shall be included by the blower vendor in the blower performance calculation.

C. Each blower shall be supplied with one combination base frame and discharge silencer or separate structural steel base and conventional discharge silencer located within the blower package enclosure. The silencer shall feature a single or double shell of pressure vessel quality steel with continuous welds. The temperature rating shall be 300°F. The design of the silencer must accommodate being bolted directly to the blower discharge flange with no intermediary pieces, and shall be designed to assure that there will be no disturbing pipe beating noise or pipe harmonics whether one blower or multiple blowers are running. The discharge silencer and acoustic enclosure shall be designed to reduce the sound pressure level emitted by the blower package such that it does not exceed the value specified in Paragraph 2.02 over the entire range of operation measured 3 feet from the front, back and at two locations opposite each side panel in free field conditions. The blower manufacturer shall supply a stainless steel grounding lug fully welded to the base or shall ground the base to the sound enclosure through a ground wire or strap.

D. Each blower package shall be connected to the plant piping via flexible connector(s) located downstream of the discharge silencer. The flexible connectors shall be suitable for the maximum operating temperature and pressure ratings of the equipment in the air stream.

E. Each blower shall be supplied with a V-belt drive and belt guard that shall be of the high capacity type, oil and heat resistant. Drive shall be designed for a minimum service factor of 1.4 times the maximum blower horsepower. Belt tensioning shall be fully automatic for maintaining proper tension. Sheaves shall be dynamically balanced regardless of the operating speed.

F. Each blower shall be supplied with vibration isolating mounts. Blower manufacturer shall be responsible for attenuating noise and vibration in the blower package.

G. The blower manufacturer shall provide a pressure relief valve located inside the enclosure and installed at the factory by the blower manufacturer. Valve shall have a 304L stainless steel body, with 316 stainless steel disc and shaft. The valve shall be field adjustable, spring loaded-type and have a proportional operating characteristic with respect to the pressure set point. Initial setting of the pressure relief valve shall be as required by the manufacturer to protect the blower from exceeding its maximum rated pressure capacity. The pressure relief valve shall be sized to pass 110% of the design flow from each blower package.

H. Check valves shall be provided on the discharge of each blower unit within the acoustic enclosure. Valves shall have 304L stainless steel bodies with 316 SST shaft, plate, and springs, and sealing member suitable for 300°F continuous service or shall be of the full-bore low pressure drop, flapper type design with an aluminum or steel body and steel flap embedded in EPDM with full contact seal all suitable for 300°F continuous service.

I. Discharge isolation valves shall be supplied and installed by the Contractor on the discharge piping outside of the enclosure. Valves shall be high performance, resilient-seated butterfly valves as specified in Section 15101S.

J. Provide a liquid-filled pressure gauge for each blower discharge and suction equal to Type 1009, Grade 1A (1.0% F.S.) as manufactured by Ashcroft, Type 2040 as manufactured by Dwyer or equal.

1. Range: 0 to 20 psig (discharge); 0 to 40 inches water gauge (suction).

2. Accuracy: ±2% of full scale.

3. Dial: 2-1/2” diameter; 270° scale; heavy gauge aluminum with white background and black markings; 1.0 psig/2 inches WC minor divisions.

4. Case: Stainless steel

5. Bourdon Tube and Socket: 316 Stainless Steel

6. Connection: ¼” or 1/8” NPT.

7. ¼” stainless steel pressure snubber.

8. Pressure gauges shall be mounted to the sound enclosure wall.

K. Provide a liquid filled bimetal thermometer for each blower discharge as manufactured by Ashcroft, Jumo or equal.

1. Range: 50 to 300°F discharge and - 40 to 160°F inlet.

2. Accuracy: ±1.5% full span.

3. Dial: 2-1/2”diameter; 270° scale; heavy gauge stainless steel with white background and black markings; 5°F minor divisions.

4. Case: Stainless steel.

5. Ring: Stainless steel.

6. Movement: Stainless steel.

7. Actuating Element: Type 304 stainless steel, precision rolled, fully annealed tubing.

8. Compensation: Bimetal compensator to offset ambient temperature changes in case area.

9. Temperature gauge shall be mounted to the sound enclosure wall.

L. A filter maintenance indicator gauge shall be provided for each blower. The indicator gauge shall be differential pressure gauge Type Magnehelic Series 2000 as manufactured by Dwyer or equal. The filter maintenance indicator gauge shall be mounted to the sound enclosure wall.

M. Each blower shall be supplied with a control and instrumentation panel with microprocessor-based controller with panel-mounted graphical operator interface terminal, Aerzen Aertronic controller, providing the following functions and features:

1. Monitoring of the following parameters: Inlet pressure, air discharge pressure, air discharge temperature, and oil temperature. Blower supplier shall furnish inlet and discharge pressure monitoring with 4-20 mA transmitters and discharge temperature monitoring with a resistance type transmitter.

2. Display operating hours and provide maintenance reminders, fault memory, summary alarm output, and run status. Memory of first-out faults, up to the last 10 occurrences, shall be maintained with display of fault, date and time.

3. Dry contacts for alarm and run permissive signals.

4. Local emergency stop button.

5. Fail-safe and shielded wiring of all transmitters: Should the wire and/or transmitter fail, the controller shall shut down the blower automatically.

6. Password protected alarm and shutdown values.

7. NEMA 4 outdoor-rated enclosure.

8. Completely factory pre-wired, programmed, and tested prior to shipment.

9. No automatic restart after the power failure.

N. Each blower shall receive its initial oil filling at the factory. Oil requirements shall be such that the oil shall be available from a local source.

2.05 BLOWER MOTORS

A. The blower manufacturer shall be responsible for furnishing a motor for each small blower package with a horsepower specified by the Offeror in Section 3.4 of the RFP. The blower motor shall be inverter rated. The manufacturer shall be responsible for the proper selection, testing, installation, and operation of the motors and for coordinating the motors with the blower equipment. Motors shall be premium efficiency motors as manufactured by WEG, SIEMENS, or equal. Motors shall be new and both materials and workmanship shall be of the very best quality. The Offeror shall ensure that the blowers supplied under this section are compatible with the VFDs and appurtenant electrical equipment provided under Division 16S.

B. Motors shall be horizontal squirrel cage induction motors designed in accordance with the latest ANSI, NEMA, and IEEE standards. Motors shall be 480 volts, 3-phase, 60 Hz. Motors shall be designed and manufactured for continuous duty for operation under the following conditions:

1. Elevation of 251 feet above mean sea level.

2. Ambient temperature ranging 0 degrees C to 45 degrees C.

3. Voltage variations of ±10 percent.

4. Frequency variation of ±5 percent.

5. Combined voltage and frequency variation of ±10 percent with frequency variation not exceeding ±5 percent.

C. Inverter duty motors shall have a minimum service factor of 1.0 and non-inverter duty motors shall have a minimum service factor of 1.15. Motor horsepower shall be equal to or greater than the load over the full range of operating conditions. Motor speed shall not exceed 1,800 rpm.

D. Motor torque characteristics shall be at least 20 percent greater than the maximum full load torque requirements over the full range of operating conditions from start-up to full load.

E. Motor enclosure shall be TEFC corrosion protected. Motor shall be designed for quiet operation. Motor sound pressure shall not exceed 77 dBA at 3 feet from the motor.

F. Motors shall provide premium efficiencies and power factors throughout their operating range. The power factors specified shall be achieved without the use of power factor correction capacitors. Motors shall provide minimum efficiencies and power factors as specified in NEMA-MG1

G. Efficiencies and power factors for each motor shall be verified by submittal of certified test reports for similar motors.

H. Motor insulation shall be a minimum of Class F. However, temperature rise shall be limited to that of Class B insulation. Manufacturer's premium grade insulation shall be used.

I. The stator shall be assembled from high grade electrical sheet steel laminations adequately secured together. Stator windings and end turn connections shall be fully braced to withstand all mechanical, electrical, and thermal stresses. The shaft shall be made of high grade machine steel or steel forging and of size and design adequate to withstand the load stresses. The rotor shall be fabricated of high grade electrical sheet steel laminations adequately fastened together and to the shaft.

J. Bearings shall be grease lube ball bearings. Split bearing housings shall be used such that bearings can be inspected or replaced without disturbing alignment.

K. Motor leads shall be suitably marked and identified. Each motor shall be provided with an oversized terminal box with space for connections and shall be constructed of cast iron or fabricated steel, neoprene gasketed and bolted.

L. Motors shall be designed and manufactured for operation in the direction required for the blowers. The phase sequence shall be marked permanently and plainly inside the stator lead junction box.

M. Motors shall have breather and drain plugs to allow for drainage of any moisture from inside.

N. Each motor shall be provided with normally closed motor winding temperature switches, one per phase, wired in series. The motor temperature switches shall be wired to the VFD by the Contractor.

O. Motors shall be supplied with space heaters for 120V operation.

P. Motors shall comply with Section 15170S, except where modified herein.

2.06 ACOUSTICAL ENCLOSURE (CLOSE-FITTING TYPE)

A. Each blower shall be supplied with a sound enclosure designed for indoor installation covering the entire blower package including the drive motor, the inlet silencer, and the discharge silencer. The sound enclosure must be designed for easy inspection and maintenance of all blower package components.

1. Panels shall be made of steel sheet, externally coated with a premium coating system. Sound enclosure acoustic material as a minimum shall comply with UL 94 or UL 723 for fire-retardant, self-extinguishing, non-dripping materials. Materials with a lesser rating shall not be acceptable.

2. A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts.

3. Quick release panels, each less than 50 lbs. shall provide easy and quick access for routine maintenance of the blower and the package components. For panels heavier than 50 lbs., hinged doors shall be supplied, with the appropriate frame, reinforcements and supporting elements.

4. A high efficiency motor driven ventilation fan shall provide ventilation and cooling integral to the sound enclosure and shall operate whenever the blower is operating. The Offeror shall provide the required interlock between the 110V cooling fan and the 480 volt starter for the blower. The fan shall be capable of limiting the temperature within the acoustical enclosure to 125°F with an outside temperature of 105°F. Cooling fan shall be sized for sufficient heat removal from the sound enclosure. Alternatively, the ventilation fan may be connected directly to the blower shaft such that the fan operates when the blower runs.

5. All enclosure fasteners and anchor bolts shall be Type 316 stainless steel. Anchor bolts shall be designed by the manufacturer.

2.07 SPARE PARTS

A. Furnish all special tools and appliances necessary to disassemble, service, repair and adjust the equipment and appurtenances.

B. Spare parts which are identical and interchangeable with the original parts shall be furnished in clearly identifiable and labeled containers. The Offeror shall provide the following spare parts:

- Two (2) filter elements per blower
- One (1) year supply of manufacturers recommended oil, per blower
- One (1) oil filter per blower
- One set of V-belts per blower

PART 3 -- EXECUTION

3.01 SHOP TESTING

A. Shop testing shall be in accordance with Section 11000S, Sidestream Deammonification System and with the following additional requirements:

B. A detailed shop test plan shall be submitted with the Shop Drawings. The shop test plan shall fully describe the manufacturer's test facilities and the test procedure to be used.

C. After assembly, each blower system shall be factory lubricated, aligned and operationally tested. Run time on each blower shall be at least 30 minutes, after which each blower shall be rechecked for alignment and tension of V-belts and adjusted if necessary. If adjustments are made, the blower(s) shall be restarted and run an additional 15 minutes, shut down and rechecked again.

D. Each blower system shall be provided with a bench test complying with ISO 1217 to demonstrate compliance with all specified performance requirements.

E. A report on each blower system shall be furnished with the O&M manuals giving as a minimum the following readings taken during shop tests at or near the end of the 30 minute run time.

1. Motor current, per phase.
2. Applied motor voltage, phase-to-phase
3. Blower shaft power draw, horsepower
4. Discharge pressure, psi
5. Air Flow, scfm
6. Air Flow, icfm
7. Blower discharge air temperature, °F
8. Vibration levels in inch/second of blower housing in horizontal, vertical and axial direction.
9. Blower inlet air temperature, °F
10. Barometer, psia
11. Relative humidity, %
12. Speed, rpm
13. Sound pressure level in dBA measured at 3 ft. from the blower system in six locations: one on each short side of the blower, and two on each long side of the blower. A comparison shall be made of tested performance to specified performance including calculations of variance from specified requirements.

F. Performance tests shall be conducted over the specified blower speed range. Tolerances allowable in testing shall be as approved by the Engineer.

G. A comparison shall be made of tested performance to specified performance including calculation of variance from specified requirements.

H. In case of failure of any unit to meet the test requirements, the manufacturer, at his own expense, shall make such alterations as are necessary and the tests shall be repeated without additional cost to Owner until the equipment is satisfactory.

I. Complete instrumentation layout and manufacturer's information for all instrumentation used during testing shall be submitted including the arrangement and device for flow measurement, conversion tables/graphs, and accuracies over the specified flow range. All instruments and measuring devices that the manufacturer proposes to use for shop performance testing shall be calibrated by a laboratory not more than twelve months prior to the first performance test.

J. The blower manufacturer shall prepare and submit test results, performance curves at standard and design inlet conditions, and all calculations with a statement certifying that shop tests were successfully conducted in accordance with the test requirements and that all specified performance conditions were demonstrated for each blower system.

3.02 MANUFACTURER’S FIELD SERVICES

A. Manufacturer’s field services shall be in accordance with Specification 11000S, Sidestream Deammonification System, and as specified herein.

B. Assist Contractor during installation to include observation, guidance, and instruction of the manufacturer’s recommended procedures for assembly, erection, installation and application.

C. Inspect, check, and adjust equipment as required for equipment to function as guaranteed.

D. At a minimum, the number of days indicated below shall be provided on an 8-hour-day on-site basis and shall be in addition to travel time. The number of days at the site shall be increased as necessary, without change to the proposal price or schedule, to accomplish the Work of this Section. Minimum service durations by the manufacturer are as follows:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	2
Startup and Training	1	2
Services after Startup	1	1

E. Training shall be provided by the manufacturer in accordance with Section 11000S.

F. A written report covering the manufacturer’s representative's findings at each visit and at installation approval shall be submitted to the Engineer. The report shall cover all inspections and shall outline in detail any deficiencies noted and all corrective measures taken or recommended.

3.03 INSTALLATION AND FIELD TESTING

A. The equipment shall be installed in accordance with the instructions and drawings of the manufacturer, Section 11000S - Equipment General Provisions.

B. The Offeror shall furnish and the Contractor shall install the blower packages and all related items in strict accordance with manufacturer's instructions including proper support and anchoring of the blowers. All supports, fasteners, anchors, equipment, hardware, etc. shall be furnished for a complete installation.

C. Prior to field testing of blower equipment, the Contractor shall take all necessary precautions to ensure that the air piping is completely clean and free of any debris, dirt, or other foreign materials which could clog the aeration equipment or interfere with acceptable operation.

D. After each blower unit and its accessories have been completely installed and the electrical connections have been made, it shall be subjected to field tests conducted by the Contractor and witnessed by the Engineer to determine if it is free from all objectionable vibration, bearing heating, noise, or other defects. Vibration shall not exceed 0.55 in/sec at any bearing in any plane. Sound pressure level shall be measured along each side of the enclosure to verify conformance to the requirements specified herein. Each blower unit shall be subjected to running tests under actual operating conditions for a period of 12 hours during the field test. The Contractor shall make such changes of alterations in the blower units or their auxiliaries necessary for satisfactory operation as directed by the Engineer based on the results of the field tests.

3.04 PAINTING

A. Painting shall be as specified in Section 09900S unless otherwise specified herein. Blowers shall be coated with the manufacturer’s recommended premium paint system suitable for the blowers’ intended use.

B. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.

C. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.05 EQUIPMENT IDENTIFICATION

A. The blowers shall be provided with a substantial brass or stainless steel nameplate, securely fastened in a conspicuous place, and clearly inscribed with the manufacturer’s name, year of manufacture, serial number, design air flow in scfm and icfm, discharge pressure and rpm.

- END OF SECTION -

SECTION 11200S A

SIDESTREAM DEAMMONIFICATION SYSTEM A

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Description of Work:

1. This Specification covers the complete sidestream deammonification treatment system as supplied by the sidestream deammonification equipment manufacturer (Offeror) for the Loudoun Water Broad Run Water Reclamation Facility (BRWRF). This specification is related to Part 1 – engineering services to provide submittals and other information for the selected system in support of design efforts by others (Design Engineer) and Part 2 –Goods and Services for the Expansion Project. The Offeror shall generally supply sidestream deammonification equipment and associated ancillary systems for installation in the proposed sidestream deammonification reactor.

2. This specification includes labor, materials, equipment, incidentals, and appurtenances required to design, fabricate, deliver, provide installation training, commissioning, operator training, testing and placement into satisfactory operation a Sidestream Deammonification System. The work shall also include the supply of all required components for installation, including but not limited to, appropriate anchor bolts and support assemblies, lifting lugs, miscellaneous hardware, surface preparation of supplied equipment, and shop painting.

3. Equipment will be installed by the General Contractor for the Expansion Project. The Contractor shall coordinate with the Offeror for installation of Goods and provide and install interconnecting piping, supports, and appurtenances not provided by the Offeror.

4. Reference Drawings show the configuration of major equipment and controls. The equipment and controls to be provided by the Offeror are identified in the Reference Drawings. An overall Process and Instrumentation Diagram will be provided as part of the Reference Drawings. Offeror is responsible for providing all components required for a fully functional system using their typical control and protective functions including valves and instruments that may not be shown explicitly in the P&IDs or as specified herein. All configuration changes to proposed facilities that are required by the Offeror shall be clearly identified with justification in their Proposal.

5. The Offeror shall work with the Contractor to furnish, test, install, and place in satisfactory operation all equipment specified herein for the scope of supply as shown in the Reference Drawings. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Reference Drawings, the functional control descriptions shall describe the required operation, monitoring, and control of the Sidestream Deammonification System.

6. The Offeror shall review equipment and line sizing for equipment that is to be provided by the Contractor for consistency with their particular process.

7. Offeror shall identify and supply unspecified components required to provide fully functional equipment or identify and remedy operating conditions that could damage the equipment and create a warranty claim.

8. A general summary of the scope responsibilities is provided in the table below. Refer to the P&ID Drawings for further details.

Parameter	**Furnish**	**Installation**	**Controls**
Positive Displacement Blowers	Offeror	GC	Offeror
Aeration System	Offeror	GC	Offeror
Sidestream Reactor Feed Pumps	GC	GC	Offeror
Sidestream Deammonification Equipment	Offeror	GC	Offeror
Sodium Hydroxide Feed Piping	GC	GC	GC
Micronutrient Feed System	GC	GC	GC

9. Equipment shall be provided in accordance with all requirements of Section 11000S Equipment General Provisions.

10. Interconnecting Piping and Valves: Final piping sizing and arrangement / orientation will be established by Engineer during final design. All pipe and valves shall be provided in accordance with applicable sections under Division 15S, Mechanical.

11. Stainless Steel Piping shall be provided shall meet the requirements in Section 15013S.

12. Valves and actuators shall be provided shall meet the requirements in Div 15S.

13. Pipe Supports shall be provided shall meet the requirements in Section 15020S.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. The Sidestream Deammonification System will be constructed new. Dewatering Centrifuge Centrate will flow by gravity to one sidestream equalization tank. Flow to the sidestream deammonification reactor will be controlled by the operation of the Sidestream Reactor Influent (SRI) feed pumps on VFDs. Effluent from the sidestream deammonification reactor will be discharged to the Influent Sewage Pump Station via a newly constructed process drain line.

B. General Design Requirements

1. The System shall be suitable for installation in an industrial indoor/outdoor environment maintained between -17 degrees C and 45 degrees C. The installation location is a temperate climate at 250 feet above sea level and an

average relative humidity of 50 – 80%.

2. The Offeror shall design the system to minimize the frequency of equipment starts for process equipment to within the process equipment offeror's recommended limits for each piece of equipment that is under deammonification system PLC control.

3. The Offeror shall design all ancillary equipment based on the Reference Drawings and the Reference Specifications listed in the RFP. The Offeror shall submit with the RFP cut sheets and design calculations for all equipment offered.

4. The Offeror shall revise their design or equipment if it does not meet the intended purpose.

5. The Operating Conditions and Design Criteria in this Section shall serve as the basis for the Process Guarantee.

C. The operating conditions for the Sidestream Deammonification System are shown in the following table:

Parameter	**Unit**	**Startup Average Annual**	**Startup Maximum Month**	**Design Average Annual**	**Design Maximum Month**
Plant Influent flow	mgd	10.0	11.0	15.0	16.5
Equalized Centrate Flow	mgd	0.07	0.11	0.11	0.15
NH_4-N	mg N/L	856	735	808	697
TKN(1)	mg N/L	923	806	881	775
TP	mg P/L	14 to 50	14 to 50	14 to 50	14 to 50
sCOD	mg/L	130	151	154	199
tCOD	mg/L	1,583	1,674	1,674	1,764
Alkalinity	mg $CaCO_3$/L	2,500	2,500	2,500	2,500
Minimum Temperature	°C	25			
Maximum Temperature	°C	36			
NH_4-N Load	% Removal	80	70	80	70
TIN(2) Load	% Removal	70	60	70	60

(1) Offeror shall assume that all TKN is converted to ammonia in the reactor for air requirement calculations.
(2) Total Inorganic Nitrogen

1. The wastewater shall contain sufficient alkalinity, either present in the wastewater or by means of chemical addition by the Contractor/Offeror, to maintain a pH in the range of 6.3 – 7.3 in the reactors.

2. With the exception of temperature, all values listed in the operating conditions are average values, including all recycle streams. The minimum and maximum temperatures in the operating conditions are based upon a seven (7) day average.

3. The following table provides historic dewatering centrifuge polymer use for consideration in the performance of the Sidestream Deammonification System:

Parameter	Unit	Minimum	Average	Maximum
Polymer Dose[a]	gal/DT Cake	1.1[b]	2.0[b]	2.8[b]
Polymer Use[a]	gal/day	35[b]	55[b]	72[b]

[a] 3022A Univar Everfloc, 46% active cationic emulsion, 1.5% solution polymer
[b] Historic polymer usage between 2015-2017. Values shown 10th percentile, average, and 90th percentile.

4. The following table provides a special grab sampling summary of the centrate total solids and total suspended solids for consideration in the performance of the Sidestream Deammonification System:

Location	Date Collected	TSS (mg/L)	TS (mg/L)
DCEN Centrate 2	5/4/2018	92	900
DCEN Centrate 2	5/4/2018	81	1,000
DCEN Centrate 2	5/6/2018	82	1,000
DCEN Centrate 2	5/7/2018	74	900
DCEN Centrate 2	5/8/2018	80	900
DCEN Centrate 2	5/9/2018	128	900
DCEN Centrate 2	5/10/2018	104	800
DCEN Centrate 2	5/13/2018	76	900
DCEN Centrate 2	5/14/2018	96	900
DCEN Centrate 1	5/15/2018	113	800
DCEN Centrate 1	5/16/2018	120	900
DCEN Centrate 2	5/17/2018	90	900
DCEN Centrate 1	6/1/2018	68	900
DCEN Centrate 1	6/27/2018	90	1,300
DCEN Centrate 1	7/18/2018	186	900

D. The design criteria for the Sidestream Deammonification System structures are shown in the following table:

Criteria	Value
Number of Process Trains	1
Equalization Volume per Train	207,570 gallons
Number of Reactors per Train	1
Reactor Dimensions	30' Long x 30' Wide
Operating Depth (SWD)	20'
Operating Volume	134,640 gallons
Hydraulic Retention Time (design)	As Submitted in RFP
Minimum Temperature	25 deg C
Average Flow to Reactor[1]	105 gpm
Maximum Flow to Reactor	As Submitted in RFP
Total Air Requirement (Biological and Foam Suppression)	As Submitted in RFP
Number of effluent screens	As Submitted in RFP
Maximum headloss through reactor	As Submitted in RFP

[1] System design shall include up to 35 gpm additional dilution water flow.

1.03 WARRANTIES AND PROCESS GUARNATEE

A. Process Guarantee Requirements

1. The Process Guarantee shall be defined by the following table.

PROCESS GUARANTEE TABLE

Parameter	Units	90-Day Average	30-Day Maximum
NH_4-N Load	% Removal	As Submitted in RFP	As Submitted in RFP
Total Inorganic Nitrogen Load	% Removal	As Submitted in RFP	As Submitted in RFP

2. Conditions on the Process Guarantee

a. If the operating conditions for the Sidestream Deammonification System exceed the conditions below the system will be considered substantially unavailable for Performance Acceptance Testing (PAT) as defined in Part 3. This shall not relieve the Offeror from the requirement for successful completion of the Performance Acceptance Testing.

i. The running 7-day average reactor temperature shall not be lower than the minimum design temperature, and any daily temperature shall not be less than 20^{o}C.

ii. The running 7-day average reactor temperature shall not be higher than the maximum design temperature.

iii. The 7-day average applied loads shall not exceed the design loadings by more than 10%.

iv. The Performance Acceptance Test will be performed on 100% of the centrate available at the time of the testing even if centrate flows are lower than stated in the operating conditions.

b. If, during the PAT, it appears that the Process Guarantee is not being met:

i. Offeror shall have the right to operate the System as it may deem necessary for purposes of determining the nature or cause of the failure provided such operating conditions are in accordance with good engineering practices, Owner's regulatory obligations, safety rules, operational restraints, and similar requirements.

ii. Offeror shall submit all system alterations or modifications proposed to meet the Process Guarantee to the Owner for review. All system alterations or modifications to meet the Process Guarantee shall be at no cost to the Owner.

iii. The Offeror shall have the right to conduct a maximum of three PATs to meet the Process Guarantee. This right does not release the Offeror from completing the PAT within the allocated time as required in Section 01652S.

3. Operational Damages

a. The Offeror shall meet the air and chemical Guaranteed Demand values submitted in the RFP. The Performance Acceptance Testing Demand shall be proven by recording the actual system usage during each day of the test.

b. Should the Performance Acceptance Testing show that the actual air and/or chemical demand is more than the Guaranteed Demand values submitted in the RFP, the Contract Price shall be reduced based on the additional 5-year operating costs for air and/or chemicals as calculated in the table below. No credit shall be provided if the air and/or chemical demand is less than the guaranteed demand.

c. The air and chemical Demand Guarantee values will be entered in the Table below from the RFP Responses. The PAT Demand values will be entered after completion of testing and the difference in demand will then be calculated.

	Demand Guarantee		PAT Demand		Difference		
	Avg Annual	Max Month	Daily Avg	Max Month	Daily Avg	Max Month	Per Year(1)
scfm of air/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					
lb of NaOH/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					
lb of micronutrients/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					

(1) The difference in usage per will be calculated assuming 75% of the year at daily average difference and 25% of the year at max month difference.

d. The additional air and chemical used over 5 years of System operation will be calculated in the table below after completion of testing.

	Difference per Year(1)	Additional Quantity Used(2)					
		Year 1	Year 2	Year 3	Year 4	Year 5	Total
Scfm of air							
lb of NaOH							
lb of micronutrients							

(1) From the table above.
(2) Each years usage will be calculated based on the following TIN load:
Year 1: 146,000 lbs TIN Removed, Year 2: 187,245 lbs TIN Removed, Year 3: 228,490 lbs TIN Removed, Year 4: 269,735 lbs TIN Removed, Year 5: 310,980 lbs TIN Removed

e. The operating cost for the additional air and chemical used will be calculated in the table below after completion of testing.

	Total	Rate	Cost
	Additional quantity used(1)	$/qty	Reduction in Contract Price
Scfm of air		$0.0033	
lb of NaOH		$0.31	
lb of micronutrients		$5.55	
		Total	
(1) From the table above.			

B. Sidestream Deammonification System Warranty

1. During the Correction Period (defined as one (1) year after the date of the Notice of Substantial Completion based on Loudoun Water's General Conditions for Construction Contracts), the Offeror shall furnish an equipment warranty certificate assuring the Sidestream Deammonification System and Equipment meet the service conditions and process guarantee specified in this Section.

1.04 SUBMITTALS

A. Part 1 – Special Engineering Services:

1. The following items shall be submitted in accordance with and in addition to the submittal requirements of Section 01302S and Section 11000S.

a. Schematics Drawings:

i. Process flow diagrams detailing all deammonification system processes and design flows.

ii. P&IDs of the System detailing the equipment supplied by the Offeror and showing equipment provided by others that will interface with the System.

iii. Provide a P&ID of a typical deammonification reactor detailing the size, quantity and control of equipment to be supplied or controlled by the Offeror.

iv. The Engineer and Loudoun Water are responsible for establishing the P&ID tag numbering for the reactor and the system. The identification and tag numbering shall be in accordance with Section 01616S, Asset Management.

v. Electrical schematic diagrams including motor horsepower and other electrical load information and identification of external wiring (panel) connections required for coordination with the Contractor.

b. Reactor Arrangement Drawings: The Offeror shall coordinate and submit each of the following Arrangement drawings for approval:

i. Plan and elevation views of the sidestream reactor basin.

ii. Clearly identified termination points and physical location for hydraulic, pneumatic and electrical connections where interfacing Offeror supplied equipment with equipment to be installed by the Contractor.

iii. A bill of materials for all tagged devices and components supplied for the deammonification reactor including component part numbers identifying each furnished component

iv. Installation drawings and templates for the setting of anchor bolts and other structural fasteners for the System components.

c. Manufacturer's literature, cut sheets, pictures, specifications, weights, pump curves and duty points, and engineering data for all equipment including dimensions, materials, sizes, and performance data.

d. Internal Settling Zone

i. Complete detailed drawings of the proposed internal settling zone and layout for the deammonification reactors showing all pipe sizes and lengths required for the designated internal settling zone. The drawings shall also include details of the connection of the internal settling zone to piping, expansion joints, gaskets, bolts, nuts and washers, and all materials used.

ii. Drawings for the settling zone and support structure shall be designed and stamped by a currently registered Civil Engineer in the State of Virginia.

e. Diffused Aeration System

i. Complete detailed drawings of the proposed aeration system including the header, manifold, laterals, membrane diffusers, couplings, and supports. Drawings for the aeration system and supports shall be designed and stamped by a currently registered Civil Engineer in the State of Virginia.

ii. Detailed drawings of diffused air assemblies showing all components, method of construction, and attachment mechanisms to air header distribution piping.

iii. Detailed drawings of all piping connections and support components.

iv. Complete and detailed calculations showing oxygen requirements, assumed oxygen transfer efficiencies, air distribution, and determination of diffuser and aeration header requirements. Describe method of spacing of the aeration system for the purpose maintaining air distribution across the deammonification reactors.

v. Complete air headloss calculations for the aeration equipment from the top of the header to the farthest diffuser bubble release point.

vi. Provide test data to substantiate values of oxygen transfer efficiency used in the design of the aeration system.

vii. Information on the materials to be used for the header and diffuser system, manufacturer information on any equipment to be furbished, and detailed drawings showing mounting details for the system proposed.

viii. Installation instructions for the proposed system.

f. Air Scour System

i. Complete detailed drawings of the piping system including the header, drop legs, laterals, couplings, and supports. Drawings for the piping system and supports shall be designed and stamped by a currently registered Civil Engineer in the State of Virginia.

ii. Detailed drawings of all piping connection and support components.

g. A listing of all gaskets that will be provided by the Offeror and confirmation for each regarding compatibility with chemicals that will be utilized as part of the deammonification system operation.

h. Submit data as required by the applicable components of Section 11000S, Equipment General Provisions.

i. Control Panel:

i. Wiring diagrams.

ii. Panel layout drawings (exterior and interior) complete with dimensions, panel rating, and bill of materials with equipment model numbers, manufacturers, locations, and nameplates.

iii. Panel component information such as product catalog data sheets.

iv. Panel area reserved for cable access and conduit entry.

j. Instrument Submittals:

i. Product (item) name and tag number used herein and on the Contract Drawings.

ii. Catalog cuts, including complete part number breakdown information.

iii. Manufacturers complete model number.

iv. Location of the device.

v. Input - output characteristics.

vi. Range, size, and graduations.

vii. Physical size with dimensions, NEMA enclosure classification and mounting details.

viii. Materials of construction of all enclosures, wetted parts and major components.

ix. Instrument or control device sizing calculations where applicable.

x. Certified calibration data on all flow metering devices.

xi. Environmental requirements during storage and operation.

xii. Associated surge protection devices.

k. List of Control System Spare Parts.

l. Sidestream Deammonification Control System: The Offeror shall submit the system control narrative which shall detail each control sequence. This document shall include, but not be limited to the following:

i. Definitions that clearly explain subparts of the control sequences.

ii. Language describing how the process functions

iii. Operating parameters

iv. Process control panels

v. Instrumentation

vi. Communication system

vii. Power distribution center

viii. Safety equipment

ix. A communications signal summary table for the deammonification system PLC.

x. Control Logic Table summarized by each control system. This table will include detailing each component with description, alarms, operating ranges, setpoints, the action the occurs, the information provided at the HMI, and any additional information required to review and troubleshoot.

B. Part 2 – Expansion Project

1. The Offeror shall submit the following information for review in accordance Section 01300 of the Expansion Project Contract Documents.

a. All submittals marked "For Design Only" from Part 1.

b. Operation and Maintenance Manuals.

c. Software Submittal:

i. Software submittal shall include process control narrative, graphic displays, trends, system security, and reports.

d. Warranty and Factory Test Reports

e. Commissioning checklists, plans, and reports as specified in Section 01652S.

f. Operating Records during Biological Startup and Performance Testing as required in Part 3.

PART 2 – PRODUCTS

2.01 ACCEPTABLE OFFERORS

A. The following offerors have been identified to be acceptable for providing the complete Sidestream Deammonification System.

1. AnammoPAQ™ System, by Ovivo USA, LLC (of Austin, TX).

2.02 GENERAL

A. The work shall generally comprise the supply of a Sidestream Deammonification System complete with process design, seed anammox granular biomass, Aerostrip Aeration System, internal settling zone, air scour system, instrumentation, and other related appurtenances required for a complete and operable system.

B. License fees or royalties required in connection with use of the Sidestream Deammonification System shall be included in the Contract Price. The Offeror shall indemnify and hold harmless Owner against all claims, damages, losses and expenses arising out of any infringement of patent rights or copyrights incident relating to this project.

2.03 MATERIALS

A. Seed Sludge

1. The Offeror shall provide start-up seed anammox granular biomass (seed sludge). The Offeror shall provide the quantity of seed sludge to achieve the target Mixed Liquor Suspended Solids (MLSS) submitted in the RFP. The Offeror shall provide additional seed sludge at not cost to Owner if field inspection during seeding shows the quantity installed by the Contractor does achieve the MLSS concentration specified.

2. Granular biomass content shall be at least 80% (1-4 mm diameter) with an organic volatile solids content of at least 70%. The Contractor shall be responsible for storage and protection of the seed media on site as required by the Offeror, as well as installation of the seed media into the sidestream system.

3. Seed sludge shall be contained in suitable waterproof container. Removal and installation of the seed sludge shall be the responsibility of the Contractor.

4. The Contractor shall install the sludge into the reactors and maintain an accurate inventory of the number of totes installed in each reactor. These records shall be submitted to the Engineer.

B. Internal Settling Zone

1. The Offeror shall furnish an internal settling zone as specified below:

a. The internal settling zone shall be a polypropylene structure located within the reactor at the top of the reactor to retain anammox granular biomass without being influenced by rising air bubbles.

b. The internal settling zone shall be comprised of:

i. a degassing stage: in which the reactor content (including biomass, water, and air) flow in through the retention system and where air bubbles are separated from the granular biomass and;

ii. a gravity separating phase: in which the mixture of biomass and water flow allowing the relatively heavier granular biomass to settle, while fine solid particles are washed through.

c. The internal settling zone shall have a central effluent overflow gutter with adjustable overflow weirs that allow water including fine light solids to be removed from the system.

d. The internal settling zone shall have a settling hopper in which the heavier granular biomass is returned into the aerated reactor via slots at the bottom.

e. The internal settling zone shall have a cleaning system with aeration stands to allow for periodic cleaning of the internal settling zone during operation.

f. The top of the internal settling zone shall be equipped with walkable covers.

2. Installation

a. The internal settling zone shall be installed as recommended by the Offeror.

C. AIR SCOUR SYSTEM

1. The Offeror shall furnish the items listed below:

a. Lateral pipe along the width of the internal settling zone

b. Apertures on the lateral pipes to provide air scour

c. Pipe supports and associated mounting hardware

2. Materials of Construction

a. The air scour system components shall be 304/304L stainless steel .

3. The Contractor shall furnish connecting piping and supports and manual flow control valves at each drop leg. Contractor furnished piping and supports shall be subject to all submittal and material requirements listed for Offeror aeration piping and supports.

4. Installation

a. The air scour system shall be installed as recommended by the Offeror.

D. AERATION SYSTEM (FINE BUBBLE)

1. General Requirements

a. The fine bubble aeration system shall be used to transfer oxygen into deammonification reactor and to provide adequate mixing to maintain biomass in suspension.

b. Pressure at the top of the drop leg without any influence of valve or other factors of headloss shall not exceed the value stated by the Offeror in the RFP response.

c. The diffuser system shall be designed to provide the air flow rates specified by the Offeror in the RFP response. Documentation to support these values shall be provided by the Offeror. Calculations shall be provided as part of the Shop Drawing submittals in accordance with Section 01302S, Submittals.

d. The fine bubble aeration system shall be designed to provide equal air distribution to the diffusers.

e. The fine bubble aeration system shall be designed so that liquids are evacuated when air flow resumes.

f. Clean water transfer efficiency shall be based on a liquid temperature of 20°C, oxygen saturation value and transfer characteristic (KLa) equal to that of clean tap water at 20°C, and initial dissolved oxygen concentration of zero mg/l, an alpha factor of 1.0, a beta factor of 1.0, and a temperature correction factor (theta) of 1.024. Documentation to support these values shall be provided by the Offeror. Calculations shall be provided as part of the Shop Drawing submittals in accordance with Section 01302S, Submittals.

g. No tolerance shall be allowed for required minimum oxygen transfer efficiency. Tolerance for measured headloss shall be -15 percent and +10 percent.

h. The system shall be designed to be submerged within the reactor without deforming any component.

i. Submerged aeration components shall be rated for operation in temperature up to 40°C.

j. Aeration system shall be designed with space for increasing air supply by 40% in the reactor in the future.

2. The Offeror shall furnish the items listed below:

a. The aeration system shall be the Aerostrip fine bubble diffused aeration type from Ovivo USA, LLC, without exception.

b. Strip Diffuser

i. Strip diffuser membranes shall be a homogenous thermoplastic material from the polyurethane family. The membrane must be manufactured as a seamless, calendared sheet without defects or repairs. The surface of the membrane must be smooth to prevent biological growth from attaching. Membrane shall be capable of producing fine bubbles of 1 mm in diameter across the entire surface and air flow must be uniform across the entire surface.

ii. Membranes shall use check-valve perforation techniques such that pores close when air is shut off. Membranes shall hold air after air valve is closed and shall not release air until approximately 0.1-0.2 psi differential pressure is applied.

iii. Fine bubble strip diffusers shall be of flat strip design using a flexible membrane installed on the reactor floor to utilize the full side water depth. The system shall be designed to withstand the design air pressure plus a 1.5 psig surge factor.

iv. Frame

1. Air shall be supplied to the strip diffuser through a PVC fitting at the end of the diffuser. The air supply fitting shall be on the top of the diffuser so that the diffuser is mounted close to the reactor floor.

2. All frame structural components shall be made from 316 stainless steel. The base plate shall be made from 316 stainless steel and the membrane shall be fastened to the base plate using 316 SS side profiles.

3. Contractor shall confirm that any and all reactor floors are level within a 1-inch deviation.

v. Supports and Anchors

1. Anchors shall be fabricated from minimum 3/8 inch diameter type 304/304L stainless steel threaded rod. Anchors shall be suitable for insertion into concrete slab with epoxy adhesive and shall be sized for a pull out strength 5 times the calculated buoyant forces.

2. All strip diffuser supports shall be designed to compensate for a maximum floor elevation difference of ±3”.

3. All interconnecting hardware required to secure the support to the strip diffuser frame shall be provided. No field welding shall be required.

4. Support profiles, nuts, bolts, washers, and other fasteners shall be made from 304/304L stainless steel.

c. Drop Pipe and Air Distribution System

i. A 304/304L stainless steel drop pipe(s) shall be provided for the aeration grid(s) to a point approximately 3’ above the SWD. The drop pipe shall be schedule 10 pipe and connect to the Contractor supplied out-of-reactor pipe.

ii. Air header piping shall be provided along the bottom of the reactor. Air header piping shall be schedule 10 304/304L stainless steel.

iii. Polyethylene feed piping from the air header to each diffuser panel shall meet the requirements of ASTM D 1248, Type III, Class C, Category 5 Grade P34, or ISO S8,3/SDR 17.6. All polyethylene shall be provided in continuous lengths with no field welding required. Provide compression fittings to connect PE piping to diffuser and air header piping.

iv. Feed lines shall be easily connected and disconnected to allow purging of debris after installation but before operation. Each distribution pipe shall be supplied with a removable end cap or plug to allow purging of the air lines.

v. Couplings – Couplings between segments of the PVC distribution pipe shall be from 304/304L stainless steel.

b. Supports

i. All supports, anchors, and fasteners shall be from 304/304L stainless steel. Supports shall be attached to the reactor floor using epoxy type concrete anchors designed for embedment in 3,000 psi concrete. Supports shall be spaced a maximum of 6' from center to center. Anchors shall be sized for a pull-out strength of 5 times the calculated buoyant forces.

ii. The piping system shall be designed to withstand the specific field operating conditions including expansion and contraction. The piping system shall be sized to supply acceptable head loss for the specified air flow rates to avoid poor distribution between diffusers.

14. The Contractor shall furnish connecting aeration piping and supports as shown and specified. Contractor furnished aeration piping and supports shall be subject to all submittal and material requirements listed for Offeror aeration piping and supports.

15. Construction:

a. All welding shall conform to Offeror Welding Fabrication Procedures. All factory welding shall undergo pickling/passivation to prevent rust and corrosion.

16. Installation

a. Where nothing to the contrary is indicated, bolts, screws, nuts, and washers shall be 316 stainless steel.

b. The installation of the aeration equipment shall be such that upon completion of installation, all diffusers are level to ±1/8” of a common horizontal plane.

E. BLOWERS

1. The Contractor shall install blowers and shall furnish and install interconnecting piping as shown and specified. The Offeror shall furnish the items listed below:

2. Positive Displacement Blowers per Section 11185S.

F. FOAM SUPPRESSION

1. The Contractor shall provide a spray water system for foam control as specified and shown on the drawings. The spray water system shall consist of piping as specified in Section 15012 and industrial spray nozzles as manufactured by Steinen of Parsippany, NJ. The nozzles shall be model type SSM and rated for 3.5 gpm at 40 psi and 4.3 gpm at 60 psi. The spray characteristics shall be a solid jet solid cone type spray with a uniform distribution. Material of construction is 304 SS with a ½” NPT. The spray nozzles shall be capable of a 40” to 50” spray pattern from a distance of 3” height. The spray system shall cover at least 180 degrees of the reactor and nozzles shall be placed on 5 foot interval.

2. The Offeror/Contractor shall coordinate the location of the spray water piping with the other piping, equipment, supports, and conduit proposed in the reactor. Any modifications required to the spray water system shall be at no additional cost to the Owner.

2.04 FABRICATION REQUIREMENTS:

A. All welding shall be in accordance with the latest applicable codes of the American Welding Society and/or ASME Boiler Code.

B. Refer to Section 05061S for stainless steel fabrication.

C. Threaded fittings shall not be used for pipe diameters exceeding 2 inches IPS.

2.05 ANCHORS:

A. The Contractor shall furnish all anchoring hardware for the supplied equipment as recommended by the Offeror.

1. Anchor Bolts: Anchor bolts shall be Type 316 stainless steel and at least 1/2-inch in diameter. See Section 05050S, Metal Fastening for requirements. Once the assembly has been approved, calculations for anchor bolts shall be signed and sealed by a Registered Civil Professional Engineer Licensed in the Commonwealth of Virginia and submitted in accordance with Section 05050S Metal Fastening.

2. Lifting Lugs: All equipment items or component assemblies weighing in excess of 100 pounds shall be furnished with lifting lugs sized to 150% of the required load.

3. Miscellaneous Fasteners: Bolts, nuts, washers, flange backing rings, and other miscellaneous metal components not specifically addressed elsewhere in these specifications shall be Type 316 stainless steel.

B. The Contractor shall furnish all epoxy and dispensing equipment for chemical anchoring as recommended by the Offeror.

2.06 INSTRUMENTATION

A. The Offeror shall provide all instrumentation, analyzers and gauges in accordance with this specification and as required to monitor all process performance and alarms required for warranty verification. At a minimum the following instrumentation shall be included with the deammonification system.

1. Air flow meters for the blowers per Section 17710S, Thermal Dispersion Air Flow Meters.

2. pH Analyzers for the deammonification reactor per Section 17801S, pH Analyzers.

3. Conductivity Analyzers for the deammonification reactor per Section 17803S, Conductivity Analyzers.

4. Dissolved Oxygen Analyzers for the deammonification reactor per Section 17811S, Luminescent Dissolved Oxygen Analyzers.

5. Total Suspended Solids Analyzers for the deammonification reactor per Section 17823S, Turbidity Analyzers (Probe Type).

6. Nitrate Analyzers for the deammonification reactor per Section 17841S, Optical Nitrate Analyzers (Probe Type).

7. Ammonium Analyzers for the deammonification reactor per Section 17843S, Ammonium Analyzers (Probe Type).

B. Location and orientation of the gauges, switches, and seal assemblies shall be coordinated with the actual piping and equipment installations so that gauges and indicators shall be easily read and accessed for maintenance by plant personal.

C. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping and equipment installation, assemblies shall be relocated, re-oriented, re-assembled, and re-calibrated.

D. The Offeror shall review the tagging of all equipment and supply coordinated tags for the equipment as required by the Contract.

E. Prior to purchase of the instrument and control system, an English language control description shall be developed by Offeror for review by Loudoun Water and Engineer.

F. Fabrication and Material Requirements (Materials of Construction): Provide compatible materials of construction for all gauges, switches, chemical seals and transmitters that come in contact with the process fluids or air.

2.07 CONTROLS

C. The Offeror shall provide all labor, materials and incidentals to furnish, program, test, and place in operation a fully functioning control system including valves and instruments that may not be included on the reference drawing P&IDs.

1. The Offeror's control system shall include the following processes at a minimum:

    a. AnnamoPAQ^{TM} Process

    b. Sidestream Deammonification Reactor Draining

    c. Aeration Control

    d. Sidestream Reactor Influent Pumping

    e. Solids Wasting

2. The Offeror shall be responsible for complete system PLC programming for the fully functional deammonification system. Refer to Section 17120S for PLC system.

3. The Offerors PLC-based control system shall include control of the feed flow to each reactor as well as the aeration rate in each reactor. Feed and aeration rates to each reactor shall be independent in the control system. Aeration rate shall have the ability to be controlled based on a constant air flow value (scfm), a target DO setpoint (mg/L), or a combined pH and DO algorithm.

    a. In air flow mode, the PLC will vary the measured aeration rate up or down to meet the flow setpoint.

    b. In intermittent air flow mode, the PLC will provide an aeration rate to meet a flow setpoint for a set number of minutes followed by no aeration for a set number of minutes.

    c. In DO mode, the PLC shall adjust the aeration rate to increase or decrease the measured reactor DO value to meet the DO setpoint. A measured DO below the setpoint will cause the aeration rate to increase. A measured DO above the setpoint will cause the aeration rate to decrease.

4. Offeror shall assist Expansion Project systems integrator in connecting this system with the existing plant Supervisory Control and Data Acquisition (SCADA) system as required for the operation, monitoring, trending logging and reporting functions of the deammonification system and any ancillary equipment identified as Offeror scope on the P&IDs.

5. The Offeror shall provide delivery of all source code to the Owner without password protection upon completion of the project. Proprietary code, function blocks, or AddOn Instructions (AOIs) are not permitted.

6. The Offeror shall provide a full programmed CPU module as a spare.

7. Control systems include, but are not limited to the following equipment:

   a. Primary sensor / transducers, analytical instrumentation, field instruments, and associated mounting hardware.

   b. The programmable controller system including processors, communications modules, input/output racks, input/output modules, and local panel mounted operator interface computer stations.

   c. The open platform SCADA software control system.

   d. The Operator Interface Terminals.

   e. PLC panels, Local Control Panels, and enclosures.

8. All Control System requirements shall be as specified herein and in accordance with other general provisions noted in Division 17S.

2.08 REQUIREMENTS FOR INTERFACE WITH THE PLANT SCADA SYSTEM

A. The Contractor shall provide communication of information between the sidestream control panel and the plant SCADA system. The sidestream supplier shall make available all the required digital and analog information to the plant SCADA system through network communication. Refer to Section 17200S for SCADA system requirements. The Contractor shall coordinate with the instrumentation supplier under Division 17S to develop the graphic displays in the display format protocol of the plant SCADA system. The plant SCADA system shall be provided with the following information from the sidestream system:

   1. Log all monitored points for trend analysis

   2. View real-time trends

   3. View historical information

   4. Display graphs and charts

   5. Date/time history of alarms

B. The Contractor shall provide additional interface functions as required with the plant control system to monitor and control the equipment associated with the Sidestream Equalization Basin and Chemical Feed Systems.

C. The Offeror shall not connect the Sidestream control panel to the plant SCADA system until after successful completion of the Performance Acceptance Testing and the Offeror's remote ethernet connection to the control panel has been removed. The Offeror shall not at any time remotely connect to the plant SCADA system.

2.09 SPARE PARTS

A. Spare Parts shall be in accordance with Section 11000S, Equipment General Provisions.

B. A list of recommended spare parts required for normal operation and maintenance for the specific deammonification system shall be submitted for approval by the Engineer and provided by the Offeror.

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 Loudoun Water at the conclusion of the Project.

2.10 SHOP PAINTING

A. Refer to Section 09900S, Painting

2.11 LUBRICANTS

A. The Offeror shall provide lubricants in conformance with NSF standards.

B. Refer to General Terms and Conditions for safety data sheets (MSDS) submittal requirements.

PART 3 – EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided by the Offeror in accordance with Section 11000S and Section 16522S. Standard field services shall include:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Equipment Testing	1	5
Equipment Startup	1	5
Training	2	2
Services after Startup	2	2

B. In addition to the service specified above, provide manufacturer's services as required to successfully complete the system Commissioning as described in Section 01652S and herein.

C. Manufacturer's representative shall observe the installation of key components of the system, including the effluent screens and aeration system. Manufacturer shall prepare a written report of the installation, documenting compliance with the requirements of the specification and the installation instructions.

C. Manufacturer's representative shall be present for the initial startup of the system, including the installation of the seed sludge. During these visits, the manufacturer shall provide training for plant staff.

D. In addition to the training specified above, Offeror shall provide training following three months of regular system operations. Owner may elect to defer refresher training for up to one year after substantial completion.

1. The Offeror shall provide 3 days of operation and maintenance training covering system equipment provided by Offeror,

2. The training course shall be a refresher course covering System Operation, System Trouble Shooting, PLC control system and HMI stations, and System Maintenance.

3.02 STORAGE OF EQUIPMENT AND MATERIALS

A. Contractor shall store all equipment and materials as specified in Section 11000S, Equipment General Provisions.

3.03 INSTALLATION

A. Contractor shall install the equipment in accordance with Section 11000S, Equipment General Provisions, and as specified herein.

3.04 STARTUP

A. Sufficient time shall be provided in the Progress Schedule to allow the seed sludge for the Sidestream Deammonification System to be provided and for sufficient biomass to be developed onsite for proper operation of the system. Such scheduling shall take into account seasonal variations in ambient temperature and other weather. No change in the Contract Times will be authorized because of failure of Offeror-furnished seed sludge to develop sufficient biomass in sufficient time for completion of all checkout, startup, and field quality control activities required prior to Substantial Completion.

3.05 COMMISSIONING

A. Responsibilities During Commissioning

1. Offeror/Contractor shall be responsible for the following:

a. Commissioning of system including all Factory Acceptance Testing, Operational Readiness Testing, Functional Demonstration Testing, Biological Startup and Performance Acceptance Testing as specified in Section 01652S, Project Commissioning.

b. Furnish all trained personnel, services, and all incidentals required for the operation of the complete facility.

c. Operation and maintenance of the Sidestream Deammonification System in accordance with Offeror's O&M instructions, manuals and instructions.

   i. The Offeror shall be responsible for providing their own Ethernet connection and internet services to their PLC for remote monitoring and control of the system.

   ii. Offeror and Contractor shall coordinate to ensure remote connection is not interrupted. Failure to maintain continuous control could result in the restart of testing periods.

   iii. Upon Substantial Completion of the Sidestream Deammonification System, the Contractor will remove their connection to the PLC.

   iv. The Offeror shall provide emergency contact information for normal and non-working hours in case of an emergency.

d. Recording and maintaining detailed records for Biological System Startup and Performance Acceptance Testing.

   i. Records shall include all daily log sheets, operator notes, sample inspections, calibration reports, laboratory and analytical results, maintenance records, and instrumentation data logs produced in the Operation of the System.

   ii. Records shall be submitted to the Owner on a weekly basis for documentation during the Biological System Startup and Performance Acceptance Testing periods.

e. Calibrating instrumentation at the start of each test period. Calibration reports shall be provided to Owner.

f. Witnessing sampling and analysis, and transport its own samples to a lab of Offeror's choosing for analysis at Offeror's expense.

g. Carrying out adjustments to the System to optimize or improve the System's performance.

h. Providing the Owner written notice when Offeror believes the process has reached system stability (defined below) and is ready for the Performance Acceptance Test to start with the following requirements:

   i. The Basis of Design conditions are being met (although may be less than the Basis of Design); and

   ii. The System is treating 100% of available centrate at Offeror stated removal efficiency in the RFP proposal for a 30 day average.

i. Consolidating the Performance Acceptance Test data and providing the

Owner with the results in a Performance Acceptance Test Report.

2. Offeror shall be responsible for the following:

   a. Providing O&M instructions and manuals to document the system startup and operation.

   b. Inspecting the System prior to testing to ensure the System meets Offeror's specified requirements for operation.

   c. Providing qualified technical personnel to operate the system and provide technical input during start up and performance testing.

3. Owner shall be responsible for the following:

   a. Collecting samples, carrying out laboratory analysis or other tests, and furnishing labor, laboratory equipment, and supplies for the following analysis:

      i. Grab sample testing three days per week during the Biological System Startup period and Performance Acceptance Testing Period. Any additional grab sampling and analysis required shall be at Offeror's expense.

Parameter	Location	Unit
TSS	Influent/Effluent	mg/L
COD	Influent/Effluent	mg/L
sCOD	Influent/Effluent	mg/L
TKN	Influent/Effluent	mg/L
NH_4-N	Influent/Effluent	mg/L
NO_3-N	Influent/Effluent	mg/L
NO_2-N	Influent/Effluent	mg/L
TP	Influent/Effluent	mg/L
PO_4	Influent/Effluent	mg/L
DO	In Reactor	mg/L
pH	Influent/Effluent	
Alkalnity as $CaCO_3$	Influent/Effluent	mg/L
Temperature	Influent/Effluent	°C

      ii. Grab sampling and disposable kit analysis for NH_4-N, NO_3-N, and NO_2-N daily during startup.

      iii. Trace metal testing shall be performed on up to three separate occasions for Offeror's use in evaluating micronutrient requirements and addition for deammonification. Any additional trace metal testing required during the Biological System Startup or Performance Acceptance Testing periods will be at Offeror's expense.

B. Biological System Startup

1. No system or subunit shall be started-up for continuous operation unless all Goods, including instrumentation and monitoring systems, of that system or subunit have been tested and proven to be operable as intended by the Contract Documents.

2. The Offeror shall coordinate all activities with the Contractor, Loudoun Water, and the Engineer. The activities to be performed by the Offeror will be detailed in the "Biological System Startup Plan" as described in Section 01652S.

3. The Offeror shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning/placing the system into operation. The Offeror shall retain the services of the offeror's/manufacturer's representatives as required in the Contract Documents to assist with commissioning/placing into operation of the Goods. The costs of these services shall be borne by the Offeror.

4. The Offeror shall hold weekly conference calls with the Engineer, Contractor, and Owner to review start-up activities and data. It is anticipated that the Offeror will need to be on-site full-time for the first two weeks of the Biological System Startup. After the first two weeks, weekly conference calls shall be the minimum coordination between the Engineer, Contractor, and Owner. Over the remaining Biological System Startup Period, it is anticipated that the Offeror will need to be on-site for 2-day periods at a time a total of four (4) times.

5. In addition to the time specified above, Offeror shall provide manufacturer's services required to successfully complete the Biological System Startup.

C. Performance Acceptance Testing (PAT)

1. Performance Acceptance Testing shall be based on the System meeting the Process Guarantee Requirements. Measured values of the System performance shall be based upon 24-hr composite sample test results.

2. Performance Acceptance Testing shall extend for a period of 90 consecutive days.

3. Performance Acceptance Testing shall be completed by the Offeror, under the observation of the Engineer, within the allocated time identified in coordination with the Contractor selected for the Expansion Project.

4. The Offeror shall coordinate all activities with the Contractor, Loudoun Water, and the Engineer. The activities to be performed by the Offeror will be detailed in the "Performance Acceptance Testing Plan" as described in Section 01652S.

5. Contractor, Offeror, Loudoun Water or an authorized representative of Loudoun Water, and the Engineer will have weekly conference calls to review the PAT performance data. It is anticipated that a representative of the Offeror will need to be on-site for a total of 15 days over 3 trips, excluding travel time.

6. In addition to the time specified above, Offeror shall provide manufacturer’s services required to successfully complete the Performance Acceptance Testing.

7. Five (5) percent of the original contract price shall be held for final payment upon issuance of the Notice of Completed Commissioning.

8. The Offeror shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning/placing the system into operation. The Offeror shall retain the services of the offeror’s/manufacturer’s representatives as required in the Contract Documents to assist with commissioning/placing into operation of the Goods. The costs of these services shall be borne by the Offeror.

9. The Engineer shall document the time when the facilities are substantially unavailable for use by the Offeror to perform the Acceptance Testing due to circumstances beyond the Offeror’s control including but not limited to power outages or lack of feed centrate. If in the sole opinion of Loudoun Water or Engineer the facilities are substantially unavailable to the Offeror, equivalent additional Acceptance Testing time may be granted.

10. If the PAT is interrupted at the request of the Offeror by the non-conformance of the Offeror’s equipment for more than three instances or a cumulative downtime of more than six hours during the PAT, Loudoun Water or the Engineer may require that PAT be restarted from the beginning, at no additional cost to Loudoun Water.

11. After the PAT is completed, the Engineer and Loudoun Water will meet with the Offeror to determine compliance with the Contract Documents. If it is determined that the Offeror has not fulfilled the requirements of the Contract Documents, the PAT will be re-run at no additional cost to the owner.

12. If, during the PAT, it appears that the Process Guarantee is not being met:

    a. Offeror shall have the right to operate the System as it may deem necessary for purposes of determining the nature or cause of the failure provided such operating conditions are in accordance with good engineering practices, Owner’s regulatory obligations, safety rules, operational restraints, and similar requirements.

    b. Offeror shall submit all system alterations or modifications proposed to meet the Process Guarantee to the Owner for review. All system alterations or modifications to meet the Process Guarantee shall be at no cost to the Owner.

    c. The Offeror shall have the right to conduct a maximum of three PATs to meet the Process Guarantee. This right does not release the Offeror from completing the PAT within the allocated time as required in Section 01652S.

- END OF SECTION -

SECTION 11200S B

SIDESTREAM DEAMMONIFICATION SYSTEM B

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Description of Work:

1. This Specification covers the complete sidestream deammonification treatment system as supplied by the sidestream deammonification equipment manufacturer (Offeror) for the Loudoun Water Broad Run Water Reclamation Facility (BRWRF). This specification is related to Part 1 – engineering services to provide submittals and other information for the selected system in support of design efforts by others (Design Engineer) and Part 2 –Goods and Services for the Expansion Project. The Offeror shall generally supply sidestream deammonification equipment and associated ancillary systems for installation in the proposed sidestream deammonification reactor.

2. This specification includes labor, materials, equipment, incidentals, and appurtenances required to design, fabricate, deliver, provide installation training, commissioning, operator training, testing and placement into satisfactory operation a Sidestream Deammonification System. The work shall also include the supply of all required components for installation, including but not limited to, appropriate anchor bolts and support assemblies, lifting lugs, miscellaneous hardware, surface preparation of supplied equipment, and shop painting.

3. Equipment will be installed by the General Contractor for the Expansion Project. The Contractor shall coordinate with the Offeror for installation of Goods and provide and install interconnecting piping, supports, and appurtenances not provided by the Offeror.

4. Reference Drawings show the configuration of major equipment and controls. The equipment and controls to be provided by the Offeror are identified in the Reference Drawings. An overall Process and Instrumentation Diagram will be provided as part of the Reference Drawings. Offeror is responsible for providing all components required for a fully functional system using their typical control and protective functions including valves and instruments that may not be shown explicitly in the P&IDs or as specified herein. All configuration changes to proposed facilities that are required by the Offeror shall be clearly identified with justification in their Proposal.

5. The Offeror shall work with the Contractor to furnish, test, install, and place in satisfactory operation all equipment specified herein for the scope of supply as shown in the Reference Drawings. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Reference Drawings, the functional control descriptions shall describe the required operation, monitoring, and control of the Sidestream Deammonification System.

6. The Offeror shall review equipment and line sizing for equipment that is to be provided by the Contractor for consistency with their particular process.

7. Offeror shall identify and supply unspecified components required to provide fully functional equipment or identify and remedy operating conditions that could damage the equipment and create a warranty claim.

8. A general summary of the scope responsibilities is provided in the table below. Refer to the P&ID Drawings for further details.

Parameter	**Furnish**	**Installation**	**Controls**
Positive Displacement Blowers	Offeror	GC	Offeror
Aeration System	Offeror	GC	Offeror
Sidestream Reactor Feed Pumps	GC	GC	Offeror
Sidestream Deammonification Equipment	Offeror	GC	Offeror
Sodium Hydroxide Feed Piping	GC	GC	GC
Micronutrient Feed System	GC	GC	GC

9. Equipment shall be provided in accordance with all requirements of Section 11000S Equipment General Provisions.

10. Interconnecting Piping and Valves: Final piping sizing and arrangement / orientation will be established by Engineer during final design. All pipe and valves shall be provided in accordance with applicable sections under Division 15S, Mechanical.

11. Stainless Steel Piping shall be provided shall meet the requirements in Section 15013S.

12. Valves and actuators shall be provided shall meet the requirements in Div 15S.

13. Pipe Supports shall be provided shall meet the requirements in Section 15020S.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. The Sidestream Deammonification System will be constructed new. Dewatering Centrifuge Centrate will flow by gravity to one sidestream equalization tank. Flow to the sidestream deammonification reactor will be controlled by the operation of the Sidestream Reactor Influent (SRI) feed pumps on VFDs. Effluent from the sidestream deammonification reactor will be discharged to the Influent Sewage Pump Station via a newly constructed process drain line.

B. General Design Requirements

1. The System shall be suitable for installation in an industrial indoor/outdoor environment maintained between -17 degrees C and 45 degrees C. The installation location is a temperate climate at 250 feet above sea level and an

average relative humidity of 50 – 80%.

2. The Offeror shall design the system to minimize the frequency of equipment starts for process equipment to within the process equipment offeror's recommended limits for each piece of equipment that is under deammonification system PLC control.

3. The Offeror shall design all ancillary equipment based on the Reference Drawings and the Reference Specifications listed in the RFP. The Offeror shall submit with the RFP cut sheets and design calculations for all equipment offered.

4. The Offeror shall revise their design or equipment if it does not meet the intended purpose.

5. The Operating Conditions and Design Criteria in this Section shall serve as the basis for the Process Guarantee.

C. The operating conditions for the Sidestream Deammonification System are shown in the following table:

Parameter	**Unit**	**Startup Average Annual**	**Startup Maximum Month**	**Design Average Annual**	**Design Maximum Month**
Plant Influent flow	mgd	10.0	11.0	15.0	16.5
Equalized Centrate Flow	mgd	0.07	0.11	0.11	0.15
NH_4-N	mg N/L	856	735	808	697
TKN(1)	mg N/L	923	806	881	775
TP	mg P/L	14 to 50	14 to 50	14 to 50	14 to 50
sCOD	mg/L	130	151	154	199
tCOD	mg/L	1,583	1,674	1,674	1,764
Alkalinity	mg $CaCO_3$/L	2,500	2,500	2,500	2,500
Minimum Temperature	°C	25			
Maximum Temperature	°C	36			
NH_4-N Load	% Removal	80	70	80	70
TIN(2) Load	% Removal	70	60	70	60

(1) Offeror shall assume that all TKN is converted to ammonia in the reactor for air requirement calculations.

(2) Total Inorganic Nitrogen

1. The wastewater shall contain sufficient alkalinity, either present in the wastewater or by means of chemical addition by the Contractor/Offeror, to maintain a pH in the range of 6.3 – 7.3 in the reactor.

2. With the exception of temperature, all values listed in the operating conditions are average values, including all recycle streams. The minimum and maximum temperatures in the operating conditions are based upon a seven (7) day average.

3. The following table provides historic dewatering centrifuge polymer use for consideration in the performance of the Sidestream Deammonification System:

Parameter	Unit	Minimum	Average	Maximum
Polymer Dose[a]	gal/DT Cake	1.1[b]	2.0[b]	2.8[b]
Polymer Use[a]	gal/day	35[b]	55[b]	72[b]

[a] 3022A Univar Everfloc, 46% active cationic emulsion, 1.5% solution polymer
[b] Historic polymer usage between 2015-2017. Values shown 10th percentile, average, and 90th percentile.

4. The following table provides a special grab sampling summary of the centrate total solids and total suspended solids for consideration in the performance of the Sidestream Deammonification System:

Location	Date Collected	TSS (mg/L)	TS (mg/L)
DCEN Centrate 2	5/4/2018	92	900
DCEN Centrate 2	5/4/2018	81	1,000
DCEN Centrate 2	5/6/2018	82	1,000
DCEN Centrate 2	5/7/2018	74	900
DCEN Centrate 2	5/8/2018	80	900
DCEN Centrate 2	5/9/2018	128	900
DCEN Centrate 2	5/10/2018	104	800
DCEN Centrate 2	5/13/2018	76	900
DCEN Centrate 2	5/14/2018	96	900
DCEN Centrate 1	5/15/2018	113	800
DCEN Centrate 1	5/16/2018	120	900
DCEN Centrate 2	5/17/2018	90	900
DCEN Centrate 1	6/1/2018	68	900
DCEN Centrate 1	6/27/2018	90	1,300
DCEN Centrate 1	7/18/2018	186	900

D. The design criteria for the Sidestream Deammonification System structures are shown in the following table:

Criteria	Value
Number of Process Trains	1
Equalization Volume per Train	276,760 gallons
Number of Reactors per Train	1
Reactor Dimensions	30’ Long x 30’ Wide
Operating Depth (SWD)	20’
Operating Volume	134,640 gallons
Hydraulic Retention Time (design)	As Submitted in RFP
Minimum Temperature	25 deg C
Average Flow to Reactor[1]	105 gpm
Maximum Flow to Reactor	As Submitted in RFP
Total Air Requirement (Biological and Foam Suppression)	As Submitted in RFP
Number of effluent screens	As Submitted in RFP
Maximum headloss through outlet screens	As Submitted in RFP

[1] System design shall include up to 35 gpm additional dilution water flow.

1.03 WARRANTIES AND PROCESS GUARNATEE

A. Process Guarantee Requirements

1. The Process Guarantee shall be defined by the following table.

PROCESS GUARANTEE TABLE

Parameter	Units	90-Day Average	30-Day Maximum
NH_4-N Load	% Removal	As Submitted in RFP	As Submitted in RFP
Total Inorganic Nitrogen Load	% Removal	As Submitted in RFP	As Submitted in RFP

2. Conditions on the Process Guarantee

a. If the operating conditions for the Sidestream Deammonification System exceed the conditions below the system will be considered substantially unavailable for Performance Acceptance Testing (PAT) as defined in Part 3.05.C.9. This shall not relieve the Offeror from the requirement for successful completion of the Performance Acceptance Testing.

i. The running 7-day average reactor temperature shall not be lower than the minimum design temperature, and any daily temperature shall not be less than 20^{o}C.

ii. The running 7-day average reactor temperature shall not be higher than the maximum design temperature.

iii. The 7-day average applied loads shall not exceed the design loadings by more than 10%.

iv. The Performance Acceptance Test will be performed on 100% of the centrate available at the time of the testing even if centrate flows are lower than stated in the operating conditions.

b. If, during the PAT, it appears that the Process Guarantee is not being met:

i. Offeror shall have the right to operate the System as it may deem necessary for purposes of determining the nature or cause of the failure provided such operating conditions are in accordance with good engineering practices, Owner's regulatory obligations, safety rules, operational restraints, and similar requirements.

ii. Offeror shall submit all system alterations or modifications proposed to meet the Process Guarantee to the Owner for review. All system alterations or modifications to meet the Process Guarantee shall be at no cost to the Owner.

iii. The Offeror shall have the right to conduct a maximum of three PATs to meet the Process Guarantee. This right does not release the Offeror from completing the PAT within the allocated time as required in Section 01652S.

3. Operational Damages

a. The Offeror shall meet the air and chemical Guaranteed Demand values submitted in the RFP. The Performance Acceptance Testing Demand shall be proven by recording the actual system usage during each day of the test.

b. Should the Performance Acceptance Testing show that the actual air and/or chemical demand is more than the Guaranteed Demand values submitted in the RFP, the Contract Price shall be reduced based on the additional 5-year operating costs for air and/or chemicals as calculated in the table below. No credit shall be provided if the air and/or chemical demand is less than the guaranteed demand.

c. The air and chemical Demand Guarantee values will be entered in the Table below from the RFP Responses. The PAT Demand values will be entered after completion of testing and the difference in demand will then be calculated.

	Demand Guarantee		PAT Demand		Difference		
	Avg Annual	Max Month	Daily Avg	Max Month	Daily Avg	Max Month	Per Year(1)
scfm of air/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					
lb of NaOH/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					
lb of micronutrients/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					

(1) The difference in usage per will be calculated assuming 75% of the year at daily average difference and 25% of the year at max month difference.

d. The additional air and chemical used over 5 years of System operation will be calculated in the table below after completion of testing.

	Difference per Year(1)	Additional Quantity Used(2)					
		Year 1	Year 2	Year 3	Year 4	Year 5	Total
Scfm of air							
lb of NaOH							
lb of micronutrients							

(1) From the table above.
(2) Each years usage will be calculated based on the following TIN load:
Year 1: 146,000 lbs TIN Removed, Year 2: 187,245 lbs TIN Removed, Year 3: 228,490 lbs TIN Removed, Year 4: 269,735 lbs TIN Removed, Year 5: 310,980 lbs TIN Removed

e. The operating cost for the additional air and chemical used will be calculated in the table below after completion of testing.

	Total	Rate	Cost
	Additional quantity used(1)	$/qty	Reduction in Contract Price
Scfm of air		$0.0033	
lb of NaOH		$0.31	
lb of micronutrients		$0.83	
		Total	
(1) From the table above.			

B. Sidestream Deammonification System Warranty

1. During the Correction Period (defined as one (1) year after the date of the Notice of Substantial Completion based on Loudoun Water's General Conditions for Construction Contracts), the Offeror shall furnish an equipment warranty certificate assuring the Sidestream Deammonification System and Equipment meet the service conditions and process guarantee specified in this Section.

1.04 SUBMITTALS

A. Part 1 – Special Engineering Services:

1. The following items shall be submitted in accordance with and in addition to the submittal requirements of Section 01302S and Section 11000S.

   a. Schematics Drawings:

      i. Process flow diagrams detailing all deammonification system processes and design flows.

      ii. P&IDs of the System detailing the equipment supplied by the Offeror and showing equipment provided by others that will interface with the System.

      iii. Provide a P&ID of a typical deammonification reactor detailing the size, quantity and control of equipment to be supplied or controlled by the Offeror.

      iv. The Engineer and Loudoun Water are responsible for establishing the P&ID tag numbering for the reactor and the system. The identification and tag numbering shall be in accordance with Section 01616S, Asset Management.

      v. Electrical schematic diagrams including motor horsepower and other electrical load information and identification of external wiring (panel) connections required for coordination with the Contractor.

b. Reactor Arrangement Drawings: The Offeror shall coordinate and submit each of the following Arrangement drawings for approval:

i. Plan and elevation views of the sidestream reactor.

ii. Clearly identified termination points and physical location for hydraulic, pneumatic and electrical connections where interfacing Offeror supplied equipment with equipment to be installed by the Contractor.

iii. A bill of materials for all tagged devices and components supplied for the deammonification reactor including component part numbers identifying each furnished component

iv. Installation drawings and templates for the setting of anchor bolts and other structural fasteners for the System components.

c. Manufacturer's literature, cut sheets, pictures, specifications, weights, pump curves and duty points, and engineering data for all equipment including dimensions, materials, sizes, and performance data.

d. Biofilm carrier elements (media)

i. Complete detailed carrier specifications including material of construction, total area, internal area per carrier element, packing factor, specific gravity, dimensioned drawings and other pertinent data. Information shall include certified calculations and documentation of the protected surface area as defined in the previous section.

ii. A detailed plan describing the methods proposed for safe storage of the media at the site. The plan shall specify the type of tarp material required and provide a detailed drawing showing CONTRACTOR how to place and secure a tarp over the storage units of media to protect the media from the sun, precipitation, wind, and construction activities.

iii. Manufacturing quality assurance program for the media. Description should include manufacturing testing and inspection to ensure consistent quality of carrier elements. Information submitted should include QA/QC procedures used in the manufacturing process for the media.

iv. Test results showing verification of media quantities included in each packaged unit of media (i.e., super sacks). Results should indicate the amount of media included in each bag, including numbers of media and associated protected surface area, and variation in quantities between bags of media. Results shall be sufficient to allow for field verification of media quantity by counting of packaged units.

v. Provide media sample. Sample shall consist of a minimum of 30 pieces of media.

e. Media retention screens

i. Complete detailed drawings of the proposed screen assemblies and layout for the reactor showing all pipe sizes, lengths and maximum allowable span between supports of each screen assembly. The layout will also show the spatial compatibility of the screen assemblies and supports with other facilities, piping and accessories. The drawings shall also include details of the connection of the screen assemblies to piping, screen supports, anchor details, expansion joints, gaskets, bolts, nuts and washers, and all materials used.

ii. Detailed drawings and specifications for the structural supports required for the screens including mounting details. Structural support drawings, if required, shall be stamped by a currently Registered Civil Engineer in the State of Virginia.

iii. Headloss calculations for each of the reactor screen assemblies at average and peak hour flow.

f. Diffused Aeration System

i. Complete detailed drawings of the aeration system including the header, manifold, laterals, diffusers, couplings, and supports. Drawings for the aeration system and supports shall be designed and stamped by a currently registered Civil Engineer in the State of Virginia.

ii. Detailed drawings of diffused air assemblies showing all components, method of construction, and attachment mechanisms to air header distribution piping.

iii. Detailed drawings of all piping connections and support components.

iv. Complete and detailed calculations showing oxygen requirements, assumed oxygen transfer efficiencies, air distribution, and determination of diffuser and aeration header requirements. Describe method of spacing of the aeration system for the purpose maintaining air distribution across the deammonification reactors.

v. Complete air headloss calculations for the aeration equipment from the top of the header to the farthest diffuser bubble release point.

vi. Provide test data to substantiate values of oxygen transfer efficiency used in the design of the aeration system.

vii. Information on the materials to be used for the header and diffuser system, manufacturer information on any equipment to be furbished, and detailed drawings showing mounting details for the system proposed.

viii. Installation instructions for the proposed system.

g. A listing of all gaskets that will be provided by the Offeror and confirmation for each regarding compatibility with chemicals that will be utilized as part of the deammonification system operation.

h. Submit data as required by the applicable components of Section 11000S, Equipment General Provisions.

i. Control Panel:

i. Wiring diagrams.

ii. Panel layout drawings (exterior and interior) complete with dimensions, panel rating, and bill of materials with equipment model numbers, manufacturers, locations, and nameplates.

iii. Panel component information such as product catalog data sheets.

iv. Panel area reserved for cable access and conduit entry.

j. Instrument Submittals:

i. Product (item) name and tag number used herein and on the Contract Drawings.

ii. Catalog cuts, including complete part number breakdown information.

iii. Manufacturers complete model number.

iv. Location of the device.

v. Input - output characteristics.

vi. Range, size, and graduations.

vii. Physical size with dimensions, NEMA enclosure classification and mounting details.

viii. Materials of construction of all enclosures, wetted parts and major components.

ix. Instrument or control device sizing calculations where applicable.

x. Certified calibration data on all flow metering devices.

xi. Environmental requirements during storage and operation.

xii. Associated surge protection devices.

k. List of Control System Spare Parts.

l. Sidestream Deammonification Control System: The Offeror shall submit the system control narrative which shall detail each control sequence. This document shall include, but not be limited to the following:

i. Definitions that clearly explain subparts of the control sequences.

ii. Language describing how the process functions

iii. Operating parameters

iv. Process control panels

v. Instrumentation

vi. Communication system

vii. Power distribution center

viii. Safety equipment

ix. A communications signal summary table for the deammonification system PLC.

x. Control Logic Table summarized by each control system. This table will include detailing each component with description, alarms, operating ranges, setpoints, the action the occurs, the information provided at the HMI, and any additional information required to review and troubleshoot.

B. Part 2 – Expansion Project

1. The Offeror shall submit the following information for review in accordance Section 01300 of the Expansion Project Contract Documents.

a. All submittals marked “For Design Only” from Part 1.

b. Operation and Maintenance Manuals.

c. Software Submittal:

i. Software submittal shall include process control narrative, graphic displays, trends, system security, and reports.

d. Warranty and Factory Test Reports

e. Commissioning checklists, plans, and reports as specified in Section 01652S.

f. Operating Records during Biological Startup and Performance Testing as required in Part 3.

PART 2 – PRODUCTS

2.01 ACCEPTABLE OFFERORS

A. The following offerors have been identified to be acceptable for providing the complete Sidestream Deammonification System.

1. ANITA^{TM}Mox MBBR Treatment System, by Veolia Water Technologies, Inc. (of Cary, NC).

2.02 GENERAL

A. The work shall generally comprise the supply of a Sidestream Deammonification System complete with process design, biofilm carrier media, AnoxKaldnes Aeration System, AnoxKaldnes Screen Assemblies, instrumentation, and other related appurtenances required for a complete and operable system.

B. License fees or royalties required in connection with use of the Sidestream Deammonification System shall be included in the Contract Price. The Offeror shall indemnify and hold harmless Owner against all claims, damages, losses and expenses arising out of any infringement of patent rights or copyrights incident relating to this project.

2.03 MATERIALS

A. Seed Media

1. The Offeror shall provide start-up seed anammox attached to biofilm carrier elements (seed media). The Offeror shall provide the quantity of seed sludge submitted in the RFP. The Offeror shall provide additional seed sludge at not cost to Owner if field inspection during seeding shows the fraction/volume is less than specified.

2. Seed sludge shall be contained in suitable waterproof container. Removal and installation of the seed sludge shall be the responsibility of the Contractor.

3. The Contractor shall install the sludge into the reactors and maintain an accurate inventory of the number of totes installed in each reactor. These records shall be submitted to the Engineer.

B. Biofilm carrier elements (media).

1. The Offeror shall furnish the items listed below:

a. Media shall be AnoxKaldnes Matrix Sol (K5) media.

b. Material shall be an extruded, white, virgin high-density polyethylene. Recycled materials will not be accepted.

c. The nominal density of the biofilm carrier elements in bulk is 7.37 lb/ft3. The nominal specific gravity of the media shall be 0.95. Nominal effective surface area for biofilm carrier elements in bulk for biomass growth is 800 m2/m3. The nominal diameter shall be 25 mm with a height of 3.5 mm.

d. Carrier elements shall be free of foreign inclusions, air bubbles, cracking, pimples, and delamination. Media not conforming to these quality criteria will be rejected. Offeror shall adhere to the quality assurance policy provided as part of the submittals. Engineer may reject media if field inspection during final placement of the media reveals non-conformity in terms of media shape, size, or stock material integrity.

e. Media shall be contained in bags. The media in each bag shall be of known volumetric quantity such as to facilitate accurate inventory control during final placement of the media. Each bag shall have handles on the topside to assist in moving the bags from the storage location to above the reactors for final placement of the media. Seed media shall be contained in 275 gallon totes or other suitable waterproof container.

2. Installation

a. Media shall be protected during on-site storage as required by the Offeror.

b. Removal from container and installation of the seed media shall be the responsibility of the Contractor.

c. The Contractor shall install the media into the reactors and maintain an accurate inventory of the number of bags installed in each reactor. These records shall be made available to the Engineer or Offeror upon request.

C. Cylindrical Screen Assemblies

1. The Offeror shall furnish the items listed below:

a. Cylindrical Screen

i. Cylindrical Screen (Perforated Plate): 304/304L stainless steel cylindrical screens shall be provided for the reactors as shown on the contract drawings. The cylindrical screens shall be constructed of a minimum 14 gauge sheet and have a perforation pattern of a 5/8” dia. with 13/16” centers, on a staggered spacing. Each screen will have a minimum 1/4” thick plate mounting flange with two sets of anchor holes for wall mounting.

ii. Welding: All welding shall conform to Offerror Welding Fabrication Procedures.

iii. The cylindrical screen shall be designed to be submerged within the reactor without deforming any component.

iv. All welded parts and assemblies shall be shop fabricated from 304L stainless steel with a 2D finish. Unless otherwise specified, all non-welded parts and pieces shall be shop fabricated from type 304 stainless steel with a 2D finish.

v. Maximum headloss through the cylindrical screens shall not exceed 3” in each reactor at peak hydraulic flows.

2. Installation

a. Where nothing to the contrary is indicated, bolts, screws, nuts, and washers shall be 18-8 stainless steel.

b. Each cylindrical screen shall be mounted by either (8) 18-8 stainless steel threaded rods with a minimum diameter of 3/8”(direct wall mounting). The installation of the cylindrical screen shall be such that upon completion of installation, all cylindrical screens are level to ±1/8” of a common horizontal plane.

D. AERATION SYSTEM (MEDIUM BUBBLE):

1. General Requirements

a. The medium bubble aeration system shall be used to transfer oxygen into deammonification reactors and to provide adequate mixing to maintain media in suspension.

b. Pressure at the top of the drop leg without any influence of valve or other factors of headloss shall not exceed the value stated by the Offeror in the RFP response.

c. The diffuser system shall be designed to provide the air flow rates specified by the Offeror in the RFP response. Documentation to support these values shall be provided by the Offeror. Calculations shall be provided as part of the Shop Drawing submittals in accordance with Section 01302S, Submittals.

d. The medium bubble aeration system shall be designed to provide equal air distribution to the diffusers and shall also be designed to keep carrier media evenly distributed throughout the cell.

e. The medium bubble aeration system shall be designed so that liquids are evacuated when air flow resumes.

f. Clean water transfer efficiency shall be based on a liquid temperature of 20°C, oxygen saturation value and transfer characteristic (KLa) equal to that of clean tap water at 20°C, and initial dissolved oxygen concentration of zero mg/l, an alpha factor of 1.0, a beta factor of 1.0, and a temperature correction factor (theta) of 1.024. Documentation to support these values shall be provided by the Offeror. Calculations shall be provided as part of the Shop Drawing submittals in accordance with Section 01302S, Submittals.

g. No tolerance shall be allowed for required minimum oxygen transfer efficiency. Tolerance for measured headloss shall be -15 percent and +10 percent.

h. The system shall be designed to be submerged within the reactor without deforming any component.

i. All welded parts and assemblies shall be shop fabricated from 304L stainless steel with a 2D finish. Unless otherwise specified, all non-welded parts and pieces shall be shop fabricated from type 304 stainless steel with a 2D finish.

j. All flanged joints shall have 45 to 55 durometer, Shore A, EPDM gaskets.

k. Submerged aeration components shall be rated for operation in temperature up to 40°C.

l. Aeration system shall be designed with space for increasing air supply by 40% in the reactor in the future.

2. The Offeror shall furnish the items listed below:

a. Drop Pipe

i. A 304/304L stainless steel drop pipe(s) shall be provided for the aeration grid(s) to a point approximately 3' above the SWD. The drop pipe shall be schedule 10 pipe and connect to the Contractor supplied out-of-reactor pipe. Offeror scope ends with a Straub coupling.

b. Aeration Grids

i. 304/304L stainless steel aeration grid(s) shall be provided for the reactor as shown on the contract drawings. The aeration grid(s) shall be comprised of an aeration grid manifold of schedule 10 pipe with Ø1" laterals of schedule 5 pipe. The laterals shall be uniformly spaced along the length of the aeration grid manifold.

Each lateral will have a series of 4mm (5/32”) holes uniformly spaced along the bottom. The lateral pipe shall include a crimped drop pipe at the end, to provide for easy drainage, and to prevent entry of media. Each aeration grid shall be supplied with all necessary couplings and hardware.

c. Contractor shall confirm that any and all reactor floors are level within a 1-inch deviation.

d. Supports

i. Drop Pipe Supports: Drop pipe supports to be fabricated from 304/304L stainless steel. The supports shall be a minimum 2” x 2” x 3/16” angle with a minimum ¼” thick anchor plate. The support shall be secured by two (2) 18-8 stainless steel threaded rods with a minimum diameter of 5/8”. Each rod will be anchored to the concrete by chemical anchors. The drop pipes shall be secured to the support by a u-bolt. Supports shall have a maximum spacing of 9’-0”. All interconnecting hardware required to secure the support to the drop pipe shall be provided. No field welding shall be required.

ii. Aeration Grid and In-Reactor Manifold Supports: Aeration grid and in-reactor manifold supports to be fabricated from 304/304L stainless steel. Each support shall consist of a minimum 2” bearing contact between the pipe and support. The support shall be secured by two (2) 18-8 stainless steel threaded rods with a minimum diameter of 5/8”. Each rod will be anchored to the concrete by chemical anchors. The aeration grid and in-reactor manifolds shall be secured to the support by a u-bolt to prevent lateral movement. Supports shall be designed to allow for on-site height adjustment. Supports shall have a maximum spacing of 9’-0”. All interconnecting hardware required to secure the support to the aeration grid shall be provided. No field welding shall be required.

iii. All aeration grid and in-reactor manifold supports shall be designed to compensate for a maximum floor elevation difference of ±3”.

iv. All supports shall be designed to resist the load of the media in the event the reactor is drained.

3. The Contractor shall furnish connecting aeration piping and supports as shown and specified. Contractor furnished aeration piping and supports shall be subject to all submittal and material requirements listed for Offeror aeration piping and supports.

4. Construction:

   a. All welding shall conform to Offeror Welding Fabrication Procedures. All factory welding shall undergo pickling/passivation to prevent rust and corrosion.

5. Installation

   a. Where nothing to the contrary is indicated, bolts, screws, nuts, and washers shall be 316 stainless steel.

   b. The installation of the aeration equipment shall be such that upon completion of installation, all diffusers are level to ±1/8” of a common horizontal plane.

E. BLOWERS:

1. The Offeror shall furnish the items listed below:

   a. Positive Displacement Blowers per Section 11185S.

2. The Contractor shall furnish interconnecting piping and supports as shown and specified. Contractor furnished aeration piping and supports shall be subject to all submittal and material requirements listed for Offeror aeration piping and supports.

F. SUBMERSIBLE MIXERS

1. The Offeror shall furnish the items listed below.

   a. Submersible Mixers per Section 11230S.

   b. Submersible mixers shall be supplied by the Offeror to mix the contents of the reactor when air flow is reduced or stopped. The Offeror shall be responsible for determining the size and position of the mixer, and the maximum tip velocity of the propeller.

G. FOAM SUPPRESSION

1. The Offeror shall furnish the items listed below.

   a. AnoxKaldnes air lift pump assemblies complete with anchor bolts, washers and nuts.

   b. Each air lift pump shall draw water from the deammonification reactor to be spread on the reactor water surface to reduce surface foam.

2. Contractor shall furnish the items listed below.

   a. Air lift pump lifting chain.

b. Aeration piping, expansion joints and valves to air lift pumps as shown on the Contract Drawings. Contractor shall include supports and expansion couplings as account for thermal pipe expansion.

2.04 FABRICATION REQUIREMENTS

A. All welding shall be in accordance with the latest applicable codes of the American Welding Society and/or ASME Boiler Code.

B. Refer to Section 05061S for stainless steel fabrication.

C. Threaded fittings shall not be used for pipe diameters exceeding 2 inches IPS.

2.05 ANCHORS

A. The Contractor shall furnish all anchoring hardware for the supplied equipment as recommended by the Offeror.

1. Anchor Bolts: Anchor bolts shall be Type 316 stainless steel and at least 1/2-inch in diameter. See Section 05050S, Metal Fastening for requirements. Once the assembly has been approved, calculations for anchor bolts shall be signed and sealed by a Registered Civil Professional Engineer Licensed in the Commonwealth of Virginia and submitted in accordance with Section 05050S Metal Fastening.

2. Lifting Lugs: All equipment items or component assemblies weighing in excess of 100 pounds shall be furnished with lifting lugs sized to 150% of the required load.

3. Miscellaneous Fasteners: Bolts, nuts, washers, flange backing rings, and other miscellaneous metal components not specifically addressed elsewhere in these specifications shall be Type 316 stainless steel.

B. The Contractor shall furnish all epoxy and dispensing equipment for chemical anchoring as recommended by the Offeror.

2.06 INSTRUMENTATION

A. The Offeror shall provide all instrumentation, analyzers and gauges in accordance with this specification and as required to monitor all process performance and alarms required for warranty verification. At a minimum the following instrumentation shall be included with the deammonification system.

3. Air flow meters for the blowers per Section 17710S, Thermal Dispersion Air Flow Meters.

4. pH Analyzers for the deammonification reactor per Section 17801S, pH Analyzers.

5. Conductivity Analyzers for the deammonification reactor per Section 17803S, Conductivity Analyzers.

6. Dissolved Oxygen Analyzers for the deammonification reactor per Section 17811S, Luminescent Dissolved Oxygen Analyzers.

7. Total Suspended Solids Analyzers for the deammonification reactor per Section 17823S, Turbidity Analyzers (Probe Type).

8. Nitrate Analyzers for the deammonification reactor per Section 17841S, Optical Nitrate Analyzers (Probe Type).

9. Ammonium Analyzers for the deammonification reactor per Section 17843S, Ammonium Analyzers (Probe Type).

B. Location and orientation of the gauges, switches, and seal assemblies shall be coordinated with the actual piping and equipment installations so that gauges and indicators shall be easily read and accessed for maintenance by plant personal.

C. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping and equipment installation, assemblies shall be relocated, re-oriented, re-assembled, and re-calibrated.

D. All field instruments installed outdoors shall be provided with sunshades and surge protection devices (SPDs). SPDs shall be installed on incoming 120 VAC power supply of the controller and on the 4-20 mA outputs.

E. Materials of Construction

a. Provide compatible materials of construction for all gauges, switches, chemical seals and transmitters that come in contact with the process fluids or air.

2.07 CONTROLS

A. The Offeror shall provide all labor, materials and incidentals to furnish, program, startup, test, and place in operation a fully functioning control system including valves and instruments that may not be included on the reference drawing P&IDs.

1. The Offeror’s control system shall include the following processes at a minimum:

a. ANITA^{TM}Mox MBBR Process

b. Sidestream Deammonification Reactor Draining

c. Mixing

d. Aeration Control

e. Sidestream Reactor Influent Pumping

2. The Offeror shall be responsible for complete system PLC programming for the fully functional deammonification system. Refer to Section 17120S for PLC

system.

3. The Offerors PLC-based control system shall include control of the feed flow to each reactor as well as the aeration rate in each reactor. Feed and aeration rates to each reactor shall be independent in the control system. Aeration rate shall have the ability to be controlled based on a constant air flow value (scfm), a target DO setpoint (mg/L), or a combined pH and DO algorithm.

    a. In air flow mode, the PLC will vary the measured aeration rate up or down to meet the flow setpoint.

    b. In intermittent air flow mode, the PLC will provide an aeration rate to meet a flow setpoint for a set number of minutes followed by no aeration for a set number of minutes.

    c. In DO mode, the PLC shall adjust the aeration rate to increase or decrease the measured reactor DO value to meet the DO setpoint. A measured DO below the setpoint will cause the aeration rate to increase. A measured DO above the setpoint will cause the aeration rate to decrease.

    d. In pH/DO mode, a target reactor pH setpoint (constant) will cause adjustment of the DO setpoint (variable) based on whether the pH value is met. A measured pH below the setpoint will cause the variable DO setpoint to decrease. A measured pH above the setpoint will cause the variable DO setpoint to increase. Any changes in DO setpoint will cause the aeration rate to be adjusted according to the DO mode control method.

4. Offeror shall assist Expansion Project systems integrator in connecting this system with the existing plant Supervisory Control and Data Acquisition (SCADA) system as required for the operation, monitoring, trending logging and reporting functions of the deammonification system and any ancillary equipment identified as Offeror scope on the P&IDs.

5. The Offeror shall provide a full programmed CPU module as a spare.

B. Control systems include, but are not limited to the following equipment:

1. Primary sensor / transducers, analytical instrumentation, field instruments, and associated mounting hardware.

2. The programmable controller system including processors, communications modules, input/output racks, input/output modules, and local panel mounted operator interface computer stations.

3. The open platform SCADA software control system.

4. The Operator Interface Terminals.

5. PLC panels, Local Control Panels, and enclosures.

C. All Control System requirements shall be as specified herein and in accordance with other general provisions noted in Division 17S.

2.08 REQUIREMENTS FOR INTERFACE WITH THE PLANT SCADA SYSTEM

A. The Offeror shall provide communication of information between the sidestream control panel and the plant SCADA system. The sidestream supplier shall make available all the required digital and analog information to the plant SCADA system through network communication. Refer to Section 17200S for SCADA system requirements. The Offeror shall coordinate with the instrumentation supplier under Division 17S to develop the graphic displays in the display format protocol of the plant SCADA system. The plant SCADA system shall be provided with the following information from the sidestream system:

2. Log all monitored points for trend analysis

3. View real-time trends

4. View historical information

5. Display graphs and charts

6. Date/time history of alarms

B. The Contractor shall provide additional interface functions as required with the plant control system to monitor and control the equipment associated with the Sidestream Equalization Basin and Chemical Feed Systems.

C. The Offeror shall not connect the Sidestream control panel to the plant SCADA system until after successful completion of the Performance Acceptance Testing and the Offeror’s remote ethernet connection to the control panel has been removed. The Offeror shall not at any time remotely connect to the plant SCADA system.

2.09 SPARE PARTS

A. Spare Parts shall be in accordance with Section 11000S, Equipment General Provisions.

B. A list of recommended spare parts required for normal operation and maintenance for the specific deammonification system shall be submitted for approval by the Engineer and provided by the Offeror.

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 Loudoun Water at the conclusion of the Project.

2.10 SHOP PAINTING

A. Refer to Section 09900S, Painting

2.11 LUBRICANTS

A. The Offeror shall provide lubricants in conformance with NSF standards.

B. Refer to General Terms and Conditions (Offeror for material safety data sheets (MSDS) submittal requirements.

PART 3 – EXECUTION

3.01 MANUFACTURER’S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided by the Offeror in accordance with Section 11000S and Section 16522S. Standard field services shall include:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Equipment Testing	1	5
Equipment Startup	1	5
Training	2	2
Services after Startup	2	2

B. In addition to the service specified above, provide manufacturer’s services as required to successfully complete the system Commissioning as described in Section 01652S and herein.

C. Manufacturer’s representative shall observe the installation of key components of the system, including the effluent screens and aeration system. Manufacturer shall prepare a written report of the installation, documenting compliance with the requirements of the specification and the installation instructions.

C. Manufacturer’s representative shall be present for the initial startup of the system, including the installation of the seed media and wetting of the virgin media. During these visits, the manufacturer shall provide training for plant staff.

D. In addition to the training specified above, Offeror shall provide training following three months of regular system operations. Owner may elect to defer refresher training for up to one year after substantial completion.

1. The Offeror shall provide 3 days of operation and maintenance training covering system equipment provided by Offeror,

2. The training course shall be a refresher course covering System Operation, System Trouble Shooting, PLC control system and HMI stations, and System Maintenance.

3.02 STORAGE OF EQUIPMENT AND MATERIALS

A. Contractor shall store all equipment and materials as specified in Section 11000S, Equipment General Provisions.

3.03 INSTALLATION

A. Contractor shall install the equipment in accordance with Section 11000S, Equipment General Provisions, and as specified herein.

3.04 STARTUP

A. Sufficient time shall be provided in the Progress Schedule to allow fresh media conditioning and to allow the seed sludge for the Sidestream Deammonification System to be provided and for sufficient biomass to be developed onsite for proper operation of the system. Such scheduling shall take into account seasonal variations in ambient temperature and other weather. No change in the Contract Times will be authorized because of failure of Offeror-furnished seed sludge to develop sufficient biomass in sufficient time for completion of all checkout, startup, and field quality control activities required prior to Substantial Completion.

3.05 COMMISSIONING

A. Responsibilities During Commissioning

1. Offeror/Contractor shall be responsible for the following:

a. Commissioning of system including all Factory Acceptance Testing, Operational Readiness Testing, Functional Demonstration Testing, Biological Startup and Performance Acceptance Testing as specified in Section 01652S, Project Commissioning.

b. Furnish all trained personnel, services, and all incidentals required for the operation of the complete facility.

c. Operation and maintenance of the Sidestream Deammonification System in accordance with Offeror's O&M instructions, manuals and instructions.

i. The Offeror shall be responsible for providing their own Ethernet connection and internet services to their PLC for remote monitoring and control of the system.

ii. Offeror and Contractor shall coordinate to ensure remote connection is not interrupted. Failure to maintain continuous control could result in the restart of testing periods.

iii. Upon Substantial Completion of the Sidestream Deammonification System, the Contractor will remove their connection to the PLC.

iv. The Offeror shall provide emergency contact information for normal and non-working hours in case of an emergency.

d. Recording and maintaining detailed records for Biological System Startup and Performance Acceptance Testing.

i. Records shall include all daily log sheets, operator notes, sample inspections, calibration reports, laboratory and analytical results, maintenance records, and instrumentation data logs produced in the Operation of the System.

ii. Records shall be submitted to the Owner on a weekly basis for documentation during the Biological System Startup and Performance Acceptance Testing periods.

e. Calibrating instrumentation at the start of each test period. Calibration reports shall be provided to Owner.

f. Witnessing sampling and analysis, and transport its own samples to a lab of Offeror's choosing for analysis at Offeror's expense.

g. Carrying out adjustments to the System to optimize or improve the System's performance.

h. Providing the Owner written notice when Offeror believes the process has reached system stability (defined below) and is ready for the Performance Acceptance Test to start with the following requirements:

i. The Basis of Design conditions are being met (although flowrate may be less than the Basis of Design); and

ii. The System is treating 100% of available centrate at Offeror stated removal efficiency in the RFP proposal for a 30 day average.

i. Consolidating the Performance Acceptance Test data and providing the Owner with the results in a Performance Acceptance Test Report.

2. Offeror shall be responsible for the following:

a. Providing O&M instructions and manuals to document the system startup and operation.

b. Inspecting the System prior to testing to ensure the System meets Offeror's specified requirements for operation.

c. Providing qualified technical personnel to operate the system and provide technical input during start up and performance testing.

3. Owner shall be responsible for the following:

a. Collecting samples, carrying out laboratory analysis or other tests, and furnishing labor, laboratory equipment, and supplies for the following analysis:

i. Grab sample testing three days per week during the Biological System Startup period and Performance Acceptance Testing Period. Any additional grab sampling and analysis required shall be at Offeror's expense.

Parameter	Location	Unit
TSS	Influent/Effluent	mg/L
COD	Influent/Effluent	mg/L
sCOD	Influent/Effluent	mg/L
TKN	Influent/Effluent	mg/L
NH_4-N	Influent/Effluent	mg/L
NO_3-N	Influent/Effluent	mg/L
NO_2-N	Influent/Effluent	mg/L
TP	Influent/Effluent	mg/L
PO_4	Influent/Effluent	mg/L
DO	In Reactor	mg/L
pH	Influent/Effluent	
Alkalnity as $CaCO_3$	Influent/Effluent	mg/L
Temperature	Influent/Effluent	°C

ii. Grab sampling and disposable kit analysis for NH_4-N, NO_3-N, and NO_2-N daily during startup.

iii. Trace metal testing shall be performed on up to three separate occasions for Offeror's use in evaluating micronutrient requirements and addition for deammonficiation. Any additional trace metal testing required during the Biological System Startup or Performance Acceptance Testing periods will be at Offeror's expense.

B. Biological System Startup

1. No system or subunit shall be started-up for continuous operation unless all Goods, including instrumentation and monitoring systems, of that system or subunit have been tested and proven to be operable as intended by the Contract Documents.

2. The Offeror shall coordinate all activities with the Contractor, Loudoun Water, and the Engineer. The activities to be performed by the Offeror will be detailed in the "Biological System Startup Plan" as described in Section 01652S.

3. The Offeror shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning/placing the system into operation. The Offeror shall retain the services of the offeror's/manufacturer's representatives as required in the Contract Documents to assist with commissioning/placing into operation of the Goods. The costs of these services shall be borne by the Offeror.

4. The Offeror shall hold weekly conference calls with the Engineer, Contractor, and Owner to review start-up activities and data. It is anticipated that the Offeror will need to be on-site full-time for the first two weeks of the Biological System Startup. After the first two weeks, weekly conference calls shall be the minimum coordination between the Engineer, Contractor, and Owner. Over the remaining Biological System Startup Period, it is anticipated that the Offeror will need to be on-site for 2-day periods at a time a total of four (4) times.

5. In addition to the time specified above, Offeror shall provide manufacturer's services required to successfully complete the Biological System Startup.

C. Performance Acceptance Testing (PAT)

1. Performance Acceptance Testing shall be based on the System meeting the Process Guarantee Requirements. Measured values of the System performance shall be based upon 24-hr composite sample test results.

2. Performance Acceptance Testing shall extend for a period of 90 consecutive days.

3. Performance Acceptance Testing shall be completed by the Offeror, under the observation of the Engineer, within the allocated time identified in coordination with the Contractor selected for the Expansion Project.

4. The Offeror shall coordinate all activities with the Contractor, Loudoun Water, and the Engineer. The activities to be performed by the Offeror will be detailed in the "Performance Acceptance Testing Plan" as described in Section 01652S.

5. Contractor, Offeror, Loudoun Water or an authorized representative of Loudoun Water, and the Engineer will have weekly conference calls to review the PAT performance data. It is anticipated that a representative of the Offeror will need to be on-site for a total of 15 days over 3 trips, excluding travel time.

6. In addition to the time specified above, Offeror shall provide manufacturer's services required to successfully complete the Performance Acceptance Testing.

7. Five (5) percent of the original contract price shall be held for final payment upon issuance of the Notice of Completed Commissioning.

8. The Offeror shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning/placing the system into operation. The Offeror shall retain the services of the offeror's/manufacturer's representatives as required in the Contract Documents to assist with commissioning/placing into operation of the Goods. The costs of these services shall be borne by the Offeror.

9. The Engineer shall document the time when the facilities are substantially unavailable for use by the Offeror to perform the Acceptance Testing due to circumstances beyond the Offeror's control including but not limited to power outages or lack of feed centrate. If in the sole opinion of Loudoun Water or Engineer the facilities are substantially unavailable to the Offeror, equivalent

additional Performance Acceptance Testing time may be granted.

10. If the PAT is interrupted at the request of the Offeror by the non-conformance of the Offeror's equipment for more than three instances or a cumulative downtime of more than six hours during the PAT, Loudoun Water or the Engineer may require that PAT be restarted from the beginning, at no additional cost to Loudoun Water.

11. After the PAT is completed, the Engineer and Loudoun Water will meet with the Offeror to determine compliance with the Contract Documents. If it is determined that the Offeror has not fulfilled the requirements of the Contract Documents, the PAT will be re-run at no additional cost to the owner.

- END OF SECTION –

SECTION 11200S C

SIDESTREAM DEAMMONIFICATION SYSTEM C

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Description of Work:

1. This Specification covers the complete sidestream deammonification treatment system as supplied by the sidestream deammonification equipment manufacturer (Offeror) for the Loudoun Water Broad Run Water Reclamation Facility (BRWRF). This specification is related to Part 1 – engineering services to provide submittals and other information for the selected system in support of design efforts by others (Design Engineer) and Part 2 –Goods and Services for the Expansion Project. The Offeror shall generally supply sidestream deammonification equipment and associated ancillary systems for installation in the proposed sidestream deammonification reactor.

2. This specification includes labor, materials, equipment, incidentals, and appurtenances required to design, fabricate, deliver, provide installation training, commissioning, operator training, testing and placement into satisfactory operation a Sidestream Deammonification System. The work shall also include the supply of all required components for installation, including but not limited to, appropriate anchor bolts and support assemblies, lifting lugs, miscellaneous hardware, surface preparation of supplied equipment, and shop painting.

3. Equipment will be installed by the General Contractor for the Expansion Project. The Contractor shall coordinate with the Offeror for installation of Goods and provide and install interconnecting piping, supports, and appurtenances not provided by the Offeror.

4. Reference Drawings show the configuration of major equipment and controls. The equipment and controls to be provided by the Offeror are identified in the Reference Drawings. An overall Process and Instrumentation Diagram will be provided as part of the Reference Drawings. Offeror is responsible for providing all components required for a fully functional system using their typical control and protective functions including valves and instruments that may not be shown explicitly in the P&IDs or as specified herein. All configuration changes to proposed facilities that are required by the Offeror shall be clearly identified with justification in their Proposal.

5. The Offeror shall work with the Contractor to furnish, test, install, and place in satisfactory operation all equipment specified herein for the scope of supply as shown in the Reference Drawings. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Reference Drawings, the functional control descriptions shall describe the required operation, monitoring, and control of the Sidestream Deammonification System.

6. The Offeror shall review equipment and line sizing for equipment that is to be provided by the Contractor for consistency with their particular process.

7. Offeror shall identify and supply unspecified components required to provide fully functional equipment or identify and remedy operating conditions that could damage the equipment and create a warranty claim.

8. A general summary of the scope responsibilities is provided in the table below. Refer to the P&ID Drawings for further details.

Parameter	**Furnish**	**Installation**	**Controls**
Positive Displacement Blowers	Offeror	GC	Offeror
Aeration System	Offeror	GC	Offeror
Sidestream Reactor Feed Pumps	GC	GC	Offeror
Sidestream Deammonification Equipment	Offeror	GC	Offeror
Sodium Hydroxide Feed Piping	GC	GC	GC
Micronutrient Feed System	GC	GC	GC

9. Equipment shall be provided in accordance with all requirements of Section 11000S Equipment General Provisions

10. Interconnecting Piping and Valves: Final piping sizing and arrangement / orientation will be established by Engineer during final design. All pipe and valves shall be provided in accordance with applicable sections under Division 15S, Mechanical.

11. Stainless Steel Piping shall be provided shall meet the requirements in Section 15013S.

12. Valves and actuators shall be provided shall meet the requirements in Div 15S.

13. Pipe Supports shall be provided shall meet the requirements in Section 15020S.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. The Sidestream Deammonification System will be constructed new. Dewatering Centrifuge Centrate will flow by gravity to one sidestream equalization tank. Flow to the sidestream deammonification reactor will be controlled by the operation of the Sidestream Reactor Influent (SRI) feed pumps on VFDs. Effluent from the sidestream deammonification reactor will be discharged to the Influent Sewage Pump Station via a newly constructed process drain line.

B. General Design Requirements

1. The System shall be suitable for installation in an industrial indoor/outdoor environment maintained between -17 degrees C and 45 degrees C. The installation location is a temperate climate at 250 feet above sea level and an

average relative humidity of 50 – 80%.

2. The Offeror shall design the system to minimize the frequency of equipment starts for process equipment to within the process equipment offeror's recommended limits for each piece of equipment that is under deammonification system PLC control.

3. The Offeror shall design all ancillary equipment based on the Reference Drawings and the Reference Specifications listed in the RFP. The Offeror shall submit with the RFP cut sheets and design calculations for all equipment offered.

4. The Offeror shall revise their design or equipment if it does not meet the intended purpose.

5. The Operating Conditions and Design Criteria in this Section shall serve as the basis for the Process Guarantee.

C. The operating conditions for the Sidestream Deammonification System are shown in the following table:

Parameter	Unit	Startup Average Annual	Startup Maximum Month	Design Average Annual	Design Maximum Month
Plant Influent flow	mgd	10.0	11.0	15.0	16.5
Equalized Centrate Flow	mgd	0.07	0.11	0.11	0.15
NH_4-N	mg N/L	856	735	808	697
TKN(1)	mg N/L	923	806	881	775
TP	mg P/L	14 to 50	14 to 50	14 to 50	14 to 50
sCOD	mg/L	130	151	154	199
tCOD	mg/L	1,583	1,674	1,674	1,764
Alkalinity	mg $CaCO_3$/L	2,500	2,500	2,500	2,500
Minimum Temperature	°C	25			
Maximum Temperature	°C	36			
NH_4-N Load	% Removal	80	70	80	70
TIN(2) Load	% Removal	70	60	70	60

(1) Offeror shall assume that all TKN is converted to ammonia in the reactor for air requirement calculations.
(2) Total Inorganic Nitrogen

1. The wastewater shall contain sufficient alkalinity, either present in the wastewater or by means of chemical addition by the Contractor/Offeror, to maintain a pH in the range of 6.3 – 7.3 in the reactors.

2. With the exception of temperature, all values listed in the operating conditions are average values, including all recycle streams. The minimum and maximum temperatures in the operating conditions are based upon a seven (7) day average.

3. The following table provides historic dewatering centrifuge polymer use for consideration in the performance of the Sidestream Deammonification System:

Parameter	Unit	Minimum	Average	Maximum
Polymer Dose[a]	gal/DT Cake	1.1[b]	2.0[b]	2.8[b]
Polymer Use[a]	gal/day	35[b]	55[b]	72[b]

[a] 3022A Univar Everfloc, 46% active cationic emulsion, 1.5% solution polymer
[b] Historic polymer usage between 2015-2017. Values shown 10th percentile, average, and 90th percentile.

4. The following table provides a special grab sampling summary of the centrate total solids and total suspended solids for consideration in the performance of the Sidestream Deammonification System:

Location	Date Collected	TSS (mg/L)	TS (mg/L)
DCEN Centrate 2	5/4/2018	92	900
DCEN Centrate 2	5/4/2018	81	1,000
DCEN Centrate 2	5/6/2018	82	1,000
DCEN Centrate 2	5/7/2018	74	900
DCEN Centrate 2	5/8/2018	80	900
DCEN Centrate 2	5/9/2018	128	900
DCEN Centrate 2	5/10/2018	104	800
DCEN Centrate 2	5/13/2018	76	900
DCEN Centrate 2	5/14/2018	96	900
DCEN Centrate 1	5/15/2018	113	800
DCEN Centrate 1	5/16/2018	120	900
DCEN Centrate 2	5/17/2018	90	900
DCEN Centrate 1	6/1/2018	68	900
DCEN Centrate 1	6/27/2018	90	1,300
DCEN Centrate 1	7/18/2018	186	900

D. The design criteria for the Sidestream Deammonification System structures are shown in the following table:

Criteria	Value
Number of Process Trains	1
Equalization Volume per Train	276,760 gallons
Number of Reactors per Train	1
Reactor Dimensions	30’ Long x 30’ Wide
Operating Depth (SWD)	20’
Operating Volume	134,640 gallons
Hydraulic Retention Time (design)	As Submitted in RFP
Minimum Temperature	25 deg C
Average Flow to Reactor[1]	105 gpm
Maximum Flow to Reactor	As Submitted in RFP
Total Air Requirement (Biological and Foam Suppression)	As Submitted in RFP
Number of effluent screens	As Submitted in RFP
Maximum headloss through reactor	As Submitted in RFP
Maximum Design Loading Rate	As Submitted in RFP

[1] System design shall include up to 35 gpm additional dilution water flow.

1.03 WARRANTIES AND PROCESS GUARNATEE

A. Process Guarantee Requirements

1. The Process Guarantee shall be defined by the following table.

PROCESS GUARANTEE TABLE

Parameter	Units	90-Day Average	30-Day Maximum
NH_4-N Load	% Removal	As Submitted in RFP	As Submitted in RFP
Total Inorganic Nitrogen Load	% Removal	As Submitted in RFP	As Submitted in RFP

2. Conditions on the Process Guarantee

a. If the operating conditions for the Sidestream Deammonification System exceed the conditions below the system will be considered substantially unavailable for Performance Acceptance Testing (PAT) as defined in Part 3.05.C.9. This shall not relieve the Offeror from the requirement for successful completion of the Performance Acceptance Testing.

i. The running 7-day average reactor temperature shall not be lower than the minimum design temperature, and any daily temperature shall not be less than 20^{o}C.

ii. The running 7-day average reactor temperature shall not be higher than the maximum design temperature.

iii. The 7-day average applied loads shall not exceed the design loadings by more than 10%.

iv. The Performance Acceptance Test will be performed on 100% of the centrate available at the time of the testing even if centrate flows are lower than stated in the operating conditions.

b. If, during the PAT, it appears that the Process Guarantee is not being met:

i. Offeror shall have the right to operate the System as it may deem necessary for purposes of determining the nature or cause of the failure provided such operating conditions are in accordance with good engineering practices, Owner's regulatory obligations, safety rules, operational restraints, and similar requirements.

ii. Offeror shall submit all system alterations or modifications proposed to meet the Process Guarantee to the Owner for review. All system alterations or modifications to meet the Process Guarantee shall be at no cost to the Owner.

iii. The Offeror shall have the right to conduct a maximum of three PATs to meet the Process Guarantee. This right does not release the Offeror from completing the PAT within the allocated time as required in Section 01652S.

3. Operational Damages

a. The Offeror shall meet the air and chemical Guaranteed Demand values submitted in the RFP. The Performance Acceptance Testing Demand shall be proven by recording the actual system usage during each day of the test.

b. Should the Performance Acceptance Testing show that the actual air and/or chemical demand is more than the Guaranteed Demand values submitted in the RFP, the Contract Price shall be reduced based on the additional 5-year operating costs for air and/or chemicals as calculated in the table below. No credit shall be provided if the air and/or chemical demand is less than the guaranteed demand.

c. The air and chemical Demand Guarantee values will be entered in the Table below from the RFP Responses. The PAT Demand values will be entered after completion of testing and the difference in demand will then be calculated.

	Demand Guarantee		PAT Demand		Difference		
	Avg Annual	Max Month	Daily Avg	Max Month	Daily Avg	Max Month	Per Year(1)
scfm of air/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					
lb of NaOH/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					
lb of micronutrients/ lb of TIN Removed	As submitted in RFP	As submitted in RFP					
(1) The difference in usage per will be calculated assuming 75% of the year at daily average difference and 25% of the year at max month difference.							

d. The additional air and chemical used over 5 years of System operation will be calculated in the table below after completion of testing.

	Difference per Year(1)	**Additional Quantity Used(2)**					
		Year 1	Year 2	Year 3	Year 4	Year 5	Total
Scfm of air							
lb of NaOH							
lb of micronutrients							
(1) From the table above. (2) Each years usage will be calculated based on the following TIN load: Year 1: 146,000 lbs TIN Removed, Year 2: 187,245 lbs TIN Removed, Year 3: 228,490 lbs TIN Removed, Year 4: 269,735 lbs TIN Removed, Year 5: 310,980 lbs TIN Removed							

e. The operating cost for the additional air and chemical used will be calculated in the table below after completion of testing.

	Total	Rate	Cost
	Additional quantity used(1)	$/qty	Reduction in Contract Price
Scfm of air		$0.0033	
lb of NaOH		$0.31	
lb of micronutrients		$5.55	
		Total	
(1) From the table above.			

B. Sidestream Deammonification System Warranty

1. During the Correction Period (defined as one (1) year after the date of the Notice of Substantial Completion based on Loudoun Water's General Conditions for Construction Contracts), the Offeror shall furnish an equipment warranty certificate assuring the Sidestream Deammonification System and Equipment meet the service conditions and process guarantee specified in this Section.

1.04 SUBMITTALS

A. Part 1 – Special Engineering Services:

1. The following items shall be submitted in accordance with and in addition to the submittal requirements of Section 01302S and Section 11000S.

   a. Schematics Drawings:

      i. Process flow diagrams detailing all deammonification system processes and design flows.

      ii. P&IDs of the System detailing the equipment supplied by the Offeror and showing equipment provided by others that will interface with the System.

      iii. Provide a P&ID of a typical deammonification reactor detailing the size, quantity and control of equipment to be supplied or controlled by the Offeror.

      iv. The Engineer and Loudoun Water are responsible for establishing the P&ID tag numbering for the reactor and the system. The identification and tag numbering shall be in accordance with Section 01616S, Asset Management.

      v. Electrical schematic diagrams including motor horsepower and other electrical load information and identification of external wiring (panel) connections required for coordination with the Contractor.

b. Reactor Arrangement Drawings: The Offeror shall coordinate and submit each of the following Arrangement drawings for approval:

   i. Plan and elevation views of the sidestream reactor.

   ii. Clearly identified termination points and physical location for hydraulic, pneumatic and electrical connections where interfacing Offeror supplied equipment with equipment to be installed by the Contractor.

   iii. A bill of materials for all tagged devices and components supplied for the deammonification reactor including component part numbers identifying each furnished component

   iv. Installation drawings and templates for the setting of anchor bolts and other structural fasteners for the System components.

c. Manufacturer's literature, cut sheets, pictures, specifications, weights, pump curves and duty points, and engineering data for all equipment including dimensions, materials, sizes, and performance data.

d. Internal Solids Settling Device

   i. Complete detailed drawings of the internal solids setting device assembly and layout for the reactor showing all pipe sizes, lengths and maximum allowable span between supports. The layout will also show the spatial compatibility of the device assembly and supports with other facilities, piping and accessories. The drawings shall also include details of the connection of the device assembly to piping, screen supports, anchor details, expansion joints, gaskets, bolts, nuts and washers, and all materials used.

   ii. Drawings for the settling zone and supports shall be designed and stamped by a currently registered Civil Engineer in the State of Virginia.

   iii. Detailed drawings and specifications for the structural supports required for the device including mounting details.

   iv. Surface overflow rate and settling rate of the device at average and peak hour flow.

   v. Headloss through the solids settling device at average and peak hour flow.

e. Microscreen System

   i. Detailed equipment dimensional drawings and setting plans.

   ii. General lifting, erection, installation, and adjustment instructions, and recommendations.

iii. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.

iv. Details on materials of construction of all components including applicable ASTM designations.

v. Information on bearing types and bearing life.

vi. Gear box design and performance criteria and AGMA service factor.

vii. Piping schematics.

viii. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at ½, ¾, and full load; slip at full load; running, full load, and locked rotor current values; and safe running time-current curves.

ix. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

x. Equipment shop coating systems, interior and exterior.

xi. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.

xii. A list of spare parts and special tools to be provided.

f. Internal Solids Settling Device

i. Complete detailed drawings of the proposed internal solids settling device and layout for the deammonification reactors showing all pipe sizes and lengths required for the designated internal settling zone location on the Reference Drawings. The drawings shall also include details of the connection of the internal settling zone to piping, expansion joints, gaskets, bolts, nuts and washers, and all materials used.

g. Fine Bubble Aeration System

i. Complete detailed drawings of the proposed aeration system including the header, manifold, laterals, diffusers, couplings, and supports. Drawings for the aeration system and support structure shall be designed and stamped by a currently registered Civil Engineer in the State of Virginia.

ii. Detailed drawings of diffused air assemblies showing all components, method of construction, and attachment mechanisms to air header distribution piping.

iii. Detailed drawings of all piping connections and support components.

iv. Complete and detailed calculations showing oxygen requirements, assumed oxygen transfer efficiencies, air distribution, and determination of diffuser and aeration header requirements. Describe method of spacing of the aeration system for the purpose maintaining air distribution across the deammonification reactors.

v. Complete air headloss calculations for the aeration equipment from the top of the header to the farthest diffuser bubble release point.

vi. Provide test data to substantiate values of oxygen transfer efficiency used in the design of the aeration system.

vii. Information on the materials to be used for the header and diffuser system, manufacturer information on any equipment to be furbished, and detailed drawings showing mounting details for the system proposed.

viii. Installation instructions for the proposed system.

h. A listing of all gaskets that will be provided by the Offeror and confirmation for each regarding compatibility with chemicals that will be utilized as part of the deammonification system operation.

i. Submit data as required by the applicable components of Section 11000S, Equipment General Provisions.

j. Control Panel:

i. Wiring diagrams.

ii. Panel layout drawings (exterior and interior) complete with dimensions, panel rating, and bill of materials with equipment model numbers, manufacturers, locations, and nameplates.

iii. Panel component information such as product catalog data sheets.

iv. Panel area reserved for cable access and conduit entry.

k. Instrument Submittals:

i. Product (item) name and tag number used herein and on the Contract Drawings.

ii. Catalog cuts, including complete part number breakdown information.

iii. Manufacturers complete model number.

iv. Location of the device.

v. Input - output characteristics.

vi. Range, size, and graduations.

vii. Physical size with dimensions, NEMA enclosure classification and mounting details.

viii. Materials of construction of all enclosures, wetted parts and major components.

ix. Instrument or control device sizing calculations where applicable.

x. Certified calibration data on all flow metering devices.

xi. Environmental requirements during storage and operation.

xii. Associated surge protection devices.

l. List of Control System Spare Parts.

m. Sidestream Deammonification Control System: The Offeror shall submit the system control narrative which shall detail each control sequence. This document shall include, but not be limited to the following:

i. Definitions that clearly explain subparts of the control sequences.

ii. Language describing how the process functions

iii. Operating parameters

iv. Process control panels

v. Instrumentation

vi. Communication system

vii. Power distribution center

viii. Safety equipment

ix. A communications signal summary table for the deammonification system PLC.

x. Control Logic Table summarized by each control system. This table will include detailing each component with description, alarms, operating ranges, setpoints, the action the occurs, the information provided at the HMI, and any additional information required to review and troubleshoot.

B. Part 2 – Expansion Project

1. The Offeror shall submit the following information for review in accordance Section 01300 of the Expansion Project Contract Documents.

a. All submittals marked "For Design Only" from Part 1.

b. Operation and Maintenance Manuals.

c. Software Submittal:

i. Software submittal shall include process control narrative, graphic displays, trends, system security, and reports.

d. Warranty and Factory Test Reports

e. Commissioning checklists, plans, and reports as specified in Section 01652S.

f. Operating Records during Biological Startup and Performance Testing as required in Part 3.

PART 2 – PRODUCTS

2.01 ACCEPTABLE OFFERORS

A. The following offerors have been identified to be acceptable for providing the complete deammonification system.

1. Anammox-DEMON Treatment System, by World Water Works, Inc. (of Oklahoma City, OK).

2.02 GENERAL

A. The work shall generally comprise the supply of a Sidestream Deammonification System complete with process design, seed sludge, aeration system, mixer(s), Biomass Separation System including feed pump, Blowers, Internal Solids Settling Device, instrumentation, and other related appurtenances required for a complete and operable system.

B. License fees or royalties required in connection with use of the Sidestream Deammonification System shall be included in the Contract Price. The Offeror shall indemnify and hold harmless Owner against all claims, damages, losses and expenses arising out of any infringement of patent rights or copyrights incident relating to this project.

2.03 MATERIALS

A. Seed Sludge

1. The Offeror shall provide start-up seed anammox granular biomass (seed sludge). The Offeror shall provide the quantity of seed sludge to achieve the target Mixed Liquor Suspended Solids (MLSS) submitted in the RFP. The Offeror shall provide additional seed sludge at not cost to Owner if field inspection during seeding shows the quantity installed by the Contractor does achieve the MLSS concentration specified.

2. Seed sludge shall be contained in suitable waterproof container. Removal and installation of the seed sludge shall be the responsibility of the Contractor.

3. The Contractor shall install the sludge into the reactors and maintain an accurate inventory of the number of totes installed in each reactor. These records shall be submitted to the Engineer.

B. Biomass Separation System

1. The Offeror shall furnish the items listed below:

a. Microscreen System

i. A total of one (1) Microscreen shall be provided for the reactor. All wetted and structural components shall be 316L SS. The separation system shall operate for effective separation of the Anammox granules using a micro-screen sized for 50 microns made from 316L SS. The gear motor unit shall control the speed of the drum based on sensors in the unit. The Microscreen shall have an integral spray bar pump rated for 10 bar and 22 gpm to a total of 15 spray nozzles.

ii. Motors shall conform to Section 15170S Low Voltage Electric Motors.

b. Microscreen feed pumps

i. The microscreen feed pumps shall be supplied by the Offeror as submitted in the RFP and in accordance with the requirement of Section 11130S.

2. The Contractor shall provide interconnecting piping and supports and manual isolation valves as specified and shown on the Drawings.

3. Installation

a. The Biomass Separation System shall be installed as recommended by the Offeror.

C. Mixers:

1. Mixers shall be provided by the Offeror per Section 11230S, Submersible Mixers.

D. Internal Solids Settling Device (ISSD):

1. The Offeror shall provide an internal settling zone to allow for continuous operation of the deammonification system. The design shall be based on a peak effluent discharge capacity as specified for the maximum month design flowrate. Clarified effluent shall be discharged by gravity to a process drain line while the settled mixed liquor will be returned to the deammonification reactor. The ISSD shall be fabricated from Eurograde Polypropylene with 316L SS supports. The ISSD and all associated accessories shall be supplied by the Offeror.

2. Construction

a. Welding: All welding shall conform to Offeror Welding Fabrication Procedures.

b. All welded parts and assemblies shall be shop fabricated from 304L stainless steel with a 2D finish. Unless otherwise specified, all non-welded parts and pieces shall be shop fabricated from type 304 stainless steel with a 2D finish.

c. Where nothing to the contrary is indicated, bolts, screws, nuts, and washers shall be 316 stainless steel.

3. Installation

a. The internal settling zone shall be installed as recommended by the Offeror.

b. The ISSD shall be mounted by 316 stainless steel threaded rods with a minimum diameter of 3/8"(direct wall mounting). The installation of ISSD shall be such that upon completion of installation, the weir is level to ±1/8" of a common horizontal plane.

E. AERATION SYSTEM (FINE BUBBLE)

1. General Requirements

a. The fine bubble aeration system shall be used to transfer oxygen into deammonification reactor reactors and to provide adequate mixing to maintain biomass in suspension.

b. Pressure at the top of the drop leg without any influence of valve or other factors of headloss shall not exceed the value stated by the Offeror in the

RFP response.

c. The diffuser system shall be designed to provide the air flow rates specified by the Offeror in the RFP response. Documentation to support these values shall be provided by the Offeror. Calculations shall be provided as part of the Shop Drawing submittals in accordance with Section 01302S, Submittals.

d. The fine bubble aeration system shall be designed to provide equal air distribution to the diffusers.

e. The fine bubble aeration system shall be designed so that liquids are evacuated when air flow resumes.

f. Clean water transfer efficiency shall be based on a liquid temperature of 20°C, oxygen saturation value and transfer characteristic (KLa) equal to that of clean tap water at 20°C, and initial dissolved oxygen concentration of zero mg/l, an alpha factor of 1.0, a beta factor of 1.0, and a temperature correction factor (theta) of 1.024. Documentation to support these values shall be provided by the Offeror. Calculations shall be provided as part of the Shop Drawing submittals in accordance with Section 01302S, Submittals.

g. No tolerance shall be allowed for required minimum oxygen transfer efficiency. Tolerance for measured headloss shall be -15 percent and +10 percent.

h. The system shall be designed to be submerged within the reactor without deforming any component.

i. Submerged aeration components shall be rated for operation in temperature up to 40°C.

j. Aeration system shall be designed with space for increasing air supply by 40% in the reactor in the future.

2. The Offeror shall furnish the items listed below:

a. Drop Pipe

i. A 304/304L stainless steel drop pipe shall be provided for the aeration grid(s) to a point approximately 3' above the SWD. The drop pipe shall be schedule 10 pipe and connect to the Contractor supplied out-of-basin pipe. Offeror scope ends with a flanged connection.

b. Internal Aeration Manifold and Grid

i. Internal aeration manifold shall be provided along the bottom of the reactor. The aeration manifold shall be schedule 10 304/304L stainless steel.

ii. Polyethylene feed piping from the air manifold to each aeration panel shall meet the requirements of ASTM D 1248, Type III, Class C, Category 5 Grade P34, or ISO S8,3/SDR 17.6. All polyethylene shall be provided in continuous lengths with no field welding required. Provide compression fittings to connect PE piping to diffuser and air header piping.

iii. Feed lines shall be easily connected and disconnected to allow purging of debris after installation but before operation. Each distribution pipe shall be supplied with a removable end cap or plug to allow purging of the air lines.

iv. Couplings – Couplings between segments of the PVC distribution pipe shall be from 304/304L stainless steel.

c. Aeration Panels and Assemblies

i. Aeration panels shall be provided for the basin(s) as submitted in the RFP. Each fine bubble aeration panel shall be 2 m long x 1 m wide with comprised of a backing plate made of AISI 316Ti 1.4571 Stainless Steel and flexible membrane. Each aeration panel shall be supplied with all necessary flex pipe, couplings, anchor bolts, and hardware.

ii. The Contractor shall ensure that any and all basin floors are level within a 1-inch deviation.

3. Supports

a. Drop Pipe Supports: Drop pipe supports to be fabricated from 304/304L stainless steel. The supports shall be a minimum 2” x 2” x 3/16” angle with a minimum ¼” thick anchor plate. The support shall be secured by two (2) 18-8 stainless steel threaded rods with a minimum diameter of 5/8”. Each rod will be anchored to the concrete by chemical anchors. The drop pipes shall be secured to the support by a u-bolt. Supports shall have a maximum spacing of 9’-0”. All interconnecting hardware required to secure the support to the drop pipe shall be provided. No field welding shall be required.

b. In-Basin Manifold Supports: In-basin manifold supports to be fabricated from 304/304L stainless steel. Each support shall consist of a minimum 2” bearing contact between the pipe and support. The support shall be secured by two (2) 18-8 stainless steel threaded rods with a minimum diameter of 5/8”. Each rod will be anchored to the concrete by chemical anchors. The in-basin manifolds shall be secured to the support by a u-bolt to prevent lateral movement. Supports shall be designed to allow for on-site height adjustment. Supports shall have a maximum spacing of 9’-

0”. All interconnecting hardware required to secure the support to the aeration grid shall be provided. No field welding shall be required.

c. Aeration Panels: Aeration panels will be secured to the concrete by chemical anchors.

4. The Contractor shall furnish connecting aeration piping and supports as shown and specified. Contractor furnished aeration piping and supports shall be subject to all submittal and material requirements listed for Offeror aeration piping and supports.

5. Construction:

a. All welding shall conform to Offeror Welding Fabrication Procedures. All factory welding shall undergo pickling/passivation to prevent rust and corrosion.

6. Installation

a. Where nothing to the contrary is indicated, bolts, screws, nuts, and washers shall be 316 stainless steel.

b. The Contractor shall verify that any basin floor is level to within 1”.

c. The installation of the aeration equipment shall be such that upon completion of installation, all diffusers are level to ±1/8” of a common horizontal plane.

F. BLOWERS

1. The Contractor shall install blowers and shall furnish and install interconnecting piping as shown and specified. The Offeror shall furnish the items listed below:

2. Positive Displacement Blowers per Section 11185S.

G. FOAM SUPPRESSION

1. The Contractor shall provide a spray water system for foam control as indicated on the drawings. The spray water system shall consist of piping as specified in Section 15102 and industrial spray nozzles as manufactured by Steinen of Parsippany, NJ. The nozzles shall be model type SSM and rated for 3.5 gpm at 40 psi and 4.3 gpm at 60 psi. The spray characteristics shall be a solid jet solid cone type spray with a uniform distribution. Material of construction is 304 SS with a ½” NPT. The spray nozzles shall be capable of a 40” to 50” spray pattern from a distance of 3” height. The spray system shall cover at least 180 degrees of the reactor and nozzles shall be placed on 5 foot interval.

2. The Offeror/Contractor shall coordinate the location of the spray water piping with the other piping, equipment, supports, and conduit proposed in the reactor. Any

modifications required to the spray water system shall be at no additional cost to the Owner.

2.04 FABRICATION REQUIREMENTS

A. All welding shall be in accordance with the latest applicable codes of the American Welding Society and/or ASME Boiler Code.

B. Refer to Section 05061S for stainless steel fabrication.

C. Threaded fittings shall not be used for pipe diameters exceeding 2 inches IPS.

2.05 ANCHORS:

A. The Contractor shall furnish all anchoring hardware for the supplied equipment as recommended by the Offeror.

1. Anchor Bolts: Anchor bolts shall be Type 316 stainless steel and at least 1/2-inch in diameter. See Section 05050S, Metal Fastening for requirements. Once the assembly has been approved, calculations for anchor bolts shall be signed and sealed by a Registered Civil Professional Engineer Licensed in the Commonwealth of Virginia and submitted in accordance with Section 05050S Metal Fastening.

2. Lifting Lugs: All equipment items or component assemblies weighing in excess of 100 pounds shall be furnished with lifting lugs sized to 150% of the required load.

3. Miscellaneous Fasteners: Bolts, nuts, washers, flange backing rings, and other miscellaneous metal components not specifically addressed elsewhere in these specifications shall be Type 316 stainless steel.

B. The Contractor shall furnish all epoxy and dispensing equipment for chemical anchoring as recommended by the Offeror.

2.06 INSTRUMENTATION

A. The Offeror shall provide all instrumentation, analyzers and gauges in accordance with this specification and as required to monitor all process performance and alarms required for warranty verification. At a minimum the following instrumentation shall be included with the deammonification system.

1. Flow measurement for the rotating drum microscreen per Section 17701S, Magnetic Flow Meter.

2. Air flow meters for the blowers per Section 17710S, Thermal Dispersion Air Flow Meters.

3. pH Analyzers for the deammonification reactor per Section 17801S, pH Analyzers.

4. Conductivity Analyzers for the deammonification reactor per Section 17803S, Conductivity Analyzers.

5. Dissolved Oxygen Analyzers for the deammonification reactor per Section 17811S, Luminescent Dissolved Oxygen Analyzers.

4. Total Suspended Solids Analyzers for the deammonification reactor per Section 17823S, Turbidity Analyzers (Probe Type).

5. Nitrate Analyzers for the deammonification reactor per Section 17841S, Optical Nitrate Analyzers (Probe Type).

6. Ammonium Analyzers for the deammonification reactor per Section 17843S, Ammonium Analyzers (Probe Type).

B. Location and orientation of the gauges, switches, and seal assemblies shall be coordinated with the actual piping and equipment installations so that gauges and indicators shall be easily read and accessed for maintenance by plant personal.

C. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping and equipment installation, assemblies shall be relocated, re-oriented, re-assembled, and re-calibrated.

D. The Offeror shall review the tagging of all equipment and supply coordinated tags for the equipment as required by the Contract.

E. Prior to purchase of the instrument and control system, an English language control description shall be developed by Offeror for review by Loudoun Water and Engineer.

F. Fabrication and Material Requirements (Materials of Construction): Provide compatible materials of construction for all gauges, switches, chemical seals and transmitters that come in contact with the process fluids or air.

2.07 CONTROLS

C. The Offeror shall provide all labor, materials and incidentals to furnish, program, test, and place in operation a fully functioning control system including valves and instruments that may not be included on the reference drawing P&IDs.

1. The Offeror’s control system shall include the following processes at a minimum:

a. DEMON Process

b. Sidestream Deammonification Reactor Draining

c. Aeration Control

d. Sidestream Reactor Influent Pumping

e. Mixing

f. Solids Wasting (Microscreen and Microscreen Feed Pump)

2. The Offeror shall be responsible for complete system PLC programming for the fully functional deammonification system. Refer to Section 17120S for PLC system.

3. The Offerors PLC-based control system shall include control of the feed flow to each reactor as well as the aeration rate in each reactor. Feed and aeration rates to each reactor shall be independent in the control system. Aeration rate shall have the ability to be controlled based on a target DO setpoint (mg/L) or influent feed rate, however, pH set points are the primary aeration strategy control.

   a. The pH setpoints will turn the blowers on and off. A target reactor high pH setpoint will turn blowers on. When the low pH set point is reached blowers will turn off.

   b. In DO mode, the PLC shall adjust the aeration rate to increase or decrease the measured reactor DO value to meet the DO setpoint. A measured DO below the setpoint will cause the aeration rate to increase. A measured DO above the setpoint will cause the aeration rate to decrease.

   c. In feed mode, the PLC shall adjust blower vfd speed based on the influent feed pumping rate.

4. Offeror shall assist Expansion Project systems integrator in connecting this system with the existing plant Supervisory Control and Data Acquisition (SCADA) system as required for the operation, monitoring, trending logging and reporting functions of the deammonification system and any ancillary equipment identified as Offeror scope on the P&IDs.

5. The Offeror shall provide delivery of all source code to the Owner without password protection upon completion of the project. Proprietary code, function blocks, or AddOn Instructions (AOIs) are not permitted.

6. The Offeror shall provide a full programmed CPU module as a spare.

D. The systems include, but are not limited to the following equipment:

1. Primary sensor / transducers, analytical instrumentation, field instruments, and associated mounting hardware.

A. The programmable controller system including processors, communications modules, input/output racks, input/output modules, and local panel mounted operator interface computer stations.

B. The open platform SCADA software control system.

C. The Operator Interface Terminals.

D. PLC panels, Local Control Panels, and enclosures.

E. All Control System requirements shall be as specified herein and in accordance with other general provisions noted in Division 17S.

2.08 REQUIREMENTS FOR INTERFACE WITH THE PLANT SCADA SYSTEM

A. The Contractor shall provide communication of information between the sidestream control panel and the plant SCADA system. The sidestream supplier shall make available all the required digital and analog information to the plant SCADA system through network communication. Refer to Section 17200S for SCADA system requirements. The Contractor shall coordinate with the instrumentation supplier under Division 17S to develop the graphic displays in the display format protocol of the plant SCADA system. The plant SCADA system shall be provided with the following information from the sidestream system:

1. Log all monitored points for trend analysis

2. View real-time trends

3. View historical information

4. Display graphs and charts

5. Date/time history of alarms

B. The Contractor shall provide additional interface functions as required with the plant control system to monitor and control the equipment associated with the Sidestream Equalization Basin and Chemical Feed Systems.

C. The Offeror shall not connect the Sidestream control panel to the plant SCADA system until after successful completion of the Performance Acceptance Testing and the Offeror’s remote ethernet connection to the control panel has been removed. The Offeror shall not at any time remotely connect to the plant SCADA system.

2.09 SPARE PARTS

A. Spare Parts shall be in accordance with Section 11000S, Equipment General Provisions.

B. A list of recommended spare parts required for normal operation and maintenance for the specific deammonification system shall be submitted for approval by the Engineer and provided by the Offeror.

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 Loudoun Water at the conclusion of the Project.

2.10 SHOP PAINTING

A. Refer to Section 09900S, Painting

2.11 LUBRICANTS

A. The Offeror shall provide lubricants in conformance with NSF standards.

B. Refer to General Terms and Conditions (Offeror for material safety data sheets (MSDS) submittal requirements).

PART 3 – EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

B. The services of a qualified manufacturer's technical representative shall be provided by the Offeror in accordance with Section 11000S and Section 16522S. Standard field services shall include:

Service	Number of Trips	Number of Days/Trip
Installation and Equipment Testing	1	5
Equipment Startup	1	5
Training	2	2
Services after Startup	2	2

C. In addition to the service specified above, provide manufacturer's services as required to successfully complete the system Commissioning as described in Section 01652S and herein.

C. Manufacturer's representative shall observe the installation of key components of the system, including the effluent screens and aeration system. Manufacturer shall prepare a written report of the installation, documenting compliance with the requirements of the specification and the installation instructions.

D. Manufacturer's representative shall be present for the initial startup of the system, including the installation of the seed sludge. During these visits, the manufacturer shall provide training for plant staff.

E. In addition to the training specified above, Offeror shall provide training following three months of regular system operations. Owner may elect to defer refresher training for up to one year after substantial completion.

1. The Offeror shall provide 3 days of operation and maintenance training covering system equipment provided by Offeror,

2. The training course shall be a refresher course covering System Operation, System Trouble Shooting, PLC control system and HMI stations, and System Maintenance.

3.02 STORAGE OF EQUIPMENT AND MATERIALS

A. Contractor shall store all equipment and materials as specified in Section 11000S, Equipment General Provisions.

3.03 INSTALLATION

A. Contractor shall install the equipment in accordance with Section 11000S, Equipment General Provisions, and as specified herein.

3.04 STARTUP

A. Sufficient time shall be provided in the Progress Schedule to allow the seed sludge for the Sidestream Deammonification System to be provided and for sufficient biomass to be developed onsite for proper operation of the system. Such scheduling shall take into account seasonal variations in ambient temperature and other weather. No change in the Contract Times will be authorized because of failure of Offeror-furnished seed sludge to develop sufficient biomass in sufficient time for completion of all checkout, startup, and field quality control activities required prior to Substantial Completion.

3.05 COMMISSIONING

A. Responsibilities During Commissioning

1. Offeror/Contractor shall be responsible for the following:

a. Commissioning of system including all Factory Acceptance Testing, Operational Readiness Testing, Functional Demonstration Testing, Biological Startup and Performance Acceptance Testing as specified in Section 01652S, Project Commissioning.

b. Furnish all trained personnel, services, and all incidentals required for the operation of the complete facility.

c. Operation and maintenance of the Sidestream Deammonification System in accordance with Offeror's O&M instructions, manuals and instructions.

i. The Offeror shall be responsible for providing their own Ethernet connection and internet services to their PLC for remote monitoring and control of the system.

ii. Offeror and Contractor shall coordinate to ensure remote connection is not interrupted. Failure to maintain continuous control could result in the restart of testing periods.

iii. Upon Substantial Completion of the Sidestream Deammonification System, the Contractor will remove their connection to the PLC.

iv. The Offeror shall provide emergency contact information for normal and non-working hours in case of an emergency.

d. Recording and maintaining detailed records for Biological System Startup and Performance Acceptance Testing.

   i. Records shall include all daily log sheets, operator notes, sample inspections, calibration reports, laboratory and analytical results, maintenance records, and instrumentation data logs produced in the Operation of the System.

   ii. Records shall be submitted to the Owner on a weekly basis for documentation during the Biological System Startup and Performance Acceptance Testing periods.

e. Calibrating instrumentation at the start of each test period. Calibration reports shall be provided to Owner.

f. Witnessing sampling and analysis, and transport its own samples to a lab of Offeror's choosing for analysis at Offeror's expense.

g. Carrying out adjustments to the System to optimize or improve the System's performance.

h. Providing the Owner written notice when Offeror believes the process has reached system stability (defined below) and is ready for the Performance Acceptance Test to start with the following requirements:

   i. The Basis of Design conditions are being met (although flowrate may be less than the Basis of Design); and

   ii. The System is treating 100% of available centrate at Offeror stated removal efficiency in the RFP proposal for a 30 day average.

i. Consolidating the Performance Acceptance Test data and providing the Owner with the results in a Performance Acceptance Test Report.

2. Offeror shall be responsible for the following:

   a. Providing O&M instructions and manuals to document the system startup and operation.

   b. Inspecting the System prior to testing to ensure the System meets Offeror's specified requirements for operation.

   c. Providing qualified technical personnel to operate the system and provide technical input during start up and performance testing.

3. Owner shall be responsible for the following:

   a. Collecting samples, carrying out laboratory analysis or other tests, and furnishing labor, laboratory equipment, and supplies for the following analysis:

i. Composite testing three days per week during the Biological System Startup period and Performance Acceptance Testing Period. Any additional sampling and analysis required shall be at Offeror's expense.

Parameter	Location	Unit
TSS	Influent/Effluent	mg/L
COD	Influent/Effluent	mg/L
sCOD	Influent/Effluent	mg/L
TKN	Influent/Effluent	mg/L
NH_4-N	Influent/Effluent	mg/L
NO_3-N	Influent/Effluent	mg/L
NO_2-N	Influent/Effluent	mg/L
TP	Influent/Effluent	mg/L
PO_4	Influent/Effluent	mg/L
DO	In Reactor	mg/L
pH	Influent/Effluent	
Alkalnity as $CaCO_3$	Influent/Effluent	mg/L
Temperature	Influent/Effluent	°C

ii. Grab sampling and disposable kit analysis for NH_4-N, NO_3-N, and NO_2-N daily during startup.

iii. Trace metal testing shall be performed on up to three separate occasions for Offeror's use in evaluating micronutrient requirements and addition for deammonification. Any additional trace metal testing required during the Biological System Startup or Performance Acceptance Testing periods will be at Offeror's expense.

B. Biological System Startup

1. No system or subunit shall be started-up for continuous operation unless all Goods, including instrumentation and monitoring systems, of that system or subunit have been tested and proven to be operable as intended by the Contract Documents.

2. The Offeror shall coordinate all activities with the Contractor, Loudoun Water, and the Engineer. The activities to be performed by the Offeror will be detailed in the "Biological System Startup Plan" as described in Section 01652S.

3. The Offeror shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning/placing the system into operation. The Offeror shall retain the services of the offeror's/manufacturer's representatives as required in the Contract Documents to assist with commissioning/placing into operation of the Goods. The costs of these services shall be borne by the Offeror.

4. The Offeror shall hold weekly conference calls with the Engineer, Contractor, and Owner to review start-up activities and data. It is anticipated that the Offeror will need to be on-site full-time for the first two weeks of the Biological System Startup. After the first two weeks, weekly conference calls shall be the minimum coordination between the Engineer, Contractor, and Owner. Over the remaining Biological System Startup Period, it is anticipated that the Offeror will need to be on-site for 2-day periods at a time a total of four (4) times.

5. In addition to the time specified above, Offeror shall provide manufacturer's services required to successfully complete the Biological System Startup.

C. Performance Acceptance Testing (PAT)

1. Performance Acceptance Testing shall be based on the System meeting the Process Guarantee Requirements. Measured values of the System performance shall be based upon 24-hr composite sample test results.

2. Performance Acceptance Testing shall extend for a period of 90 consecutive days.

3. Performance Acceptance Testing shall be completed by the Offeror, under the observation of the Engineer, within the allocated time identified in coordination with the Contractor selected for the Expansion Project.

4. The Offeror shall coordinate all activities with the Contractor, Loudoun Water, and the Engineer. The activities to be performed by the Offeror will be detailed in the "Performance Acceptance Testing Plan" as described in Section 01652S.

5. Contractor, Offeror, Loudoun Water or an authorized representative of Loudoun Water, and the Engineer will have weekly conference calls to review the PAT performance data. It is anticipated that a representative of the Offeror will need to be on-site for a total of 15 days over 3 trips, excluding travel time.

6. In addition to the time specified above, Offeror shall provide manufacturer's services required to successfully complete the Performance Acceptance Testing.

7. Five (5) percent of the original contract price shall be held for final payment upon issuance of the Notice of Completed Commissioning.

8. The Offeror shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning/placing the system into operation. The Offeror shall retain the services of the offeror's/manufacturer's representatives as required in the Contract Documents to assist with commissioning/placing into operation of the Goods. The costs of these services shall be borne by the Offeror.

9. The Engineer shall document the time when the facilities are substantially unavailable for use by the Offeror to perform the Acceptance Testing due to circumstances beyond the Offeror's control including but not limited to power outages or lack of feed centrate. If in the sole opinion of Loudoun Water or

Engineer the facilities are substantially unavailable to the Offeror, equivalent additional Acceptance Testing time may be granted.

10. If the PAT is interrupted at the request of the Offeror by the non-conformance of the Offeror's equipment for more than three instances or a cumulative downtime of more than six hours during the PAT, Loudoun Water or the Engineer may require that PAT be restarted from the beginning, at no additional cost to Loudoun Water.

11. After the PAT is completed, the Engineer and Loudoun Water will meet with the Offeror to determine compliance with the Contract Documents. If it is determined that the Offeror has not fulfilled the requirements of the Contract Documents, the PAT will be re-run at no additional cost to the owner.

- END OF SECTION -

SECTION 11230S

SUBMERSIBLE MIXERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall furnish and Contractor install submersible, direct-drive, axial mixers suitable for mixing of activated sludge mixed liquor at the locations shown on the Drawings and as specified herein. Mixers and appurtenances shall be designed for continuous submergence under water without loss of watertight integrity to a depth of 50 feet. Mixers shall be able to be raised and lowered and shall be easily removable for service without the need for personnel to enter the tank. All mixers shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the requirements of Section 11000S, Equipment General Provisions and Section 11100S, Pumps - General.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. The mixers shall be capable of meeting the performance requirements and operating conditions specified by the Offeror in Section 3.4 of the RFP and as required for the Sidestream Deammonification System.

1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01302S, Submittals; and Section 11000S, Equipment General Provisions.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Each mixer shall be a submersible, direct-drive, axial mixer as manufactured by Flygt no substitutions permitted.

2.02 MATERIALS

A. The mixer and all related equipment shall be designed for the wastewater applications specified herein and shall be suitable for continuous operation under water to a depth of 50 feet without loss of watertight integrity. The mixer shall be direct-drive, axial-type construction and shall be supplied with a tripod mounting system and mast assembly including integral sliding guide bracket of the mixer manufacturer's design matched to the mixers being supplied.

B. All metal components in contact with the mixed media shall be 304 stainless steel.

C. Casing shall be a smooth surface devoid of blowholes, pits, burrs, or other irregularities. The casing shall be constructed of type 304 stainless steel designed to prevent moisture

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from entering motor compartment. Casing shall be provided with 304 stainless steel guide bracket designed to mount on support mast.

D. All mating surfaces where watertight sealing is required shall be machined and fitted with a double set of nitrile or Viton rubber 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 the requirement of a specific torque limit. Secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall not be acceptable.

E. The propeller shall be type 316 stainless steel. Propellers shall be dynamically balanced and of welded construction with non-clogging backward curved design. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in normal wastewater applications.

F. Oil housing shall contain two compartments consisting of an inner and outer section with four ports to connect and facilitate oil flow. Oil housing cover plate shall be of corrosion resistant composite.

G. Manufacturer is responsible for surface preparation, priming, and finish coating of ferrous metal components prior to shipment. Provide in accordance with Section 09900S. Stainless steel, bronze, and nonmetallic surfaces shall not be coated. Coat machined or bearing surfaces and holds with protective grease.

H. Shafting shall be constructed of 316L stainless steel and shaft seals shall have dual seals to isolate oil in housing from surrounding liquids.

I. Two sets of lapped end face type mechanical seals shall be provided in oil reservoirs. Face rings shall be of corrosion resistant tungsten of silicon carbide material. Only seal faced of outer seal assembly and its retaining clips shall be exposed to mixed media. Mechanical seals shall not require maintenance or adjustment but will be accessible to check and replace.

J. The mixer shaft shall rotate on at least two (2) heavy duty permanently lubricated bearings. Bearings shall be designed to carry all radial and axial thrust loads and shall have a minimum AFBMA B-10 life of 100,000 hours. Bearings shall have inner and outer races of metal construction. Outboard propeller bearing shall be an angular contact bearing. Bearings shall be pre-loaded by bearing loading nut located on motor end of shaft.

K. Mixer mast shall be constructed of 316 stainless steel with tripod mount and assembly shall allow for rotation of mast to allow mixing flexibility. Provide mixer with a minimum of 50-foot 316 stainless steel lifting cable. Provide 316 stainless steel wall brackets (upper, intermediate, and lower) of the quantity and locations recommended by manufacturer. See plans for tank depth. Provide cable holders and power cable support grips as recommended by manufacturer.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

A. The mixer manufacturer shall provide the power and control cables between the mixer and the local disconnect switch, junction box, or control panel (see Drawings) and shall be responsible for reviewing the electrical drawings as necessary to determine the required cable length. All mixers for the same mixing application shall be provided with the same length of cable. No splices shall be allowed unless specifically indicated on the Drawings. Cables shall be PVC or oil resistant cloroprene rubber jacketed type SPC cable suitable for submersible mixer applications, shall be sized according to NEC and ICEA standards, and shall meet with MSHA approval. Stainless steel strain relief connectors shall be furnished for all cables.

B. The cable entry water seal design shall insure a watertight and submersible seal without specific torque requirements. The cable entry shall be comprised of a set of two cylindrical elastomer grommets, flanked by stainless steel washers all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the stator casing opening and shall be compressed by a gland nut threaded into it. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate gaining access through the mixer top. The junction chamber containing the terminal board shall be sealed from the motor by an elastomer compression seal O-ring. Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to the terminal board and thus perfectly leak proof. Each mixer shall be equipped with separate terminal board that totally isolates the incoming power supply from the mixer motor.

C. Electrical Requirements

	Mixers
Motors	
Rating	As provided in RFP
Horsepower	
Speed, rpm	
Insulation	Class F
Explosion Proof	Yes
Inverter Duty	Yes
Service Factor	1.0
Motor Winding Temperature Switches	Yes
RTDs	Yes
Cooling Jacket	No

D. The motor shall be a high efficiency synchronous speed permanent magnet type with an integrated variable speed drive, housed in an air filled, watertight chamber. The motor is to be purpose built for underwater operation by the mixer manufacturer. The motor shall be directly connected to the propeller. The motor efficiency shall be tested in accordance with standard 60034-30-01 for international efficiency, class IE4 levels.

E. The mixer speed shall be adjustable via either remote communications or a separate operator panel.

F. The stator windings and stator leads shall be insulated with moisture resistant Class H (356°F) insulation. The stator shall be trickle impregnated with Class H varnish and shall be press fitted into the stator housing.

G. The motor shall be capable of an unlimited number starts per hour.

H. All motors shall be of nationally known manufacture, shall be housed in enclosures specifically designed for submersible mixer application.

I. Mixer monitoring shall provide dual function monitoring for both over-temperature via bi-metal, thermistor, or RTD sensor and seal failure via moisture sensor or float switch. Only low voltage leakage system allowed. Modules shall provide independent 100 ma, 24 VAC or 5A, 210 VAC rated Form C outputs for both over-temperature and seal failure. Module must have a 24 VAC or 24-240 VAC input power range, a 2.8 watt power consumption, and must be UL approved.

2.04 LOCAL CONTROL STATION

A. Local Control Station shall be provided as required on drawings and Specified in Division 17S. Local Control Station shall be NEMA 4X stainless steel.

2.05 SPARE PARTS

A. Spare parts shall be provided in accordance with Section 11000S, Equipment General Provisions and shall include the following for each series of pumps

One set of bearings.
One mechanical seal set.
One complete gasket set.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000S. For each series of mixers, field services shall include the following site visits:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Testing	1	1
Startup and Training	1	1
Services after Startup	1	1

3.02 SHOP TESTING

A. Shop testing shall be in accordance with Section 11000S and with the following additional requirements:

1. Impeller, motor rating and electrical connections shall be checked.

2. A motor and cable insulation test for moisture content or defective insulation shall be made.

3. Prior to submergence, the mixer shall be run dry to establish correct rotation and mechanical integrity.

4. The mixer shall be run for 30 minutes submerged, a minimum of six (6) ft. under water.

5. After the run-dry test, the insulation test shall be performed again.

6. After the run-dry test, the mixer shall be run continuously unsubmerged for 2 hours under full load with no damage to the motor. During this test, the mixer shall demonstrate compliance with the specified performance for flow, head, and horsepower and shall experience a heat rise of not greater than 45°C (80°F) above ambient temperature.

- END OF SECTION -

SECTION 15000S

BASIC MECHANICAL REQUIREMENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The requirements of this section shall apply to the general construction contractor for the Expansion Project. This section serves as a reference for components supplied by the Offeror. Loudoun Water will not directly award a purchase order for the goods and associated services for the Expansion Project but will instead assign the Procurement Agreement to the general construction contractor selected for the Expansion Project.

B. The Contractor (general contractor awarded the Expansion Project) shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.

C. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent Contracts for a complete installation.

D. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, wall sleeves, wall pipes, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.

E. Piping assemblies under 4-inch size shall be generally supported on walls and ceilings, unless otherwise shown on the Drawings or ordered by the Engineer, being kept clear of openings and positioned above "headroom" space. Where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.

F. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.

G. The work shall include, but not be limited to, the following:

1. Connections to existing pipelines.

2. Test excavations necessary to locate or verify existing pipe and appurtenances.

3. Installation of all new pipe and materials required for a complete installation.

4. Cleaning, testing and disinfecting as required.

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1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1S, General Requirements

B. Division 2S, Sitework

C. Division 9S, Finishes

D. Division 11S, Equipment

E. Division 16S, Electrical

1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

A. The Contractor shall furnish to the Owner (through the Engineer) a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.

B. Shop Drawings for major piping (2-inches in diameter and greater) shall be prepared and submitted in accordance with Section 01302S – Submittals. In addition to the requirements of Section 01302S – Submittals, the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.

C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

PART 2 – PRODUCTS

2.01 GENERAL

A. All specials and every length of pipe shall be marked with the Offeror's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.

B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified in Section 3.10.

C. Joints in piping shall be of the type as specified in the appropriate Piping System Schedule in Section 15390, Schedules, which shall be included in the Specifications or indicated in the Drawings provided as part of the Expansion Project.

D. All buried exterior piping shall have restrained joints for thrust protection unless otherwise specified or shown on the drawings. All exposed exterior piping shall have flanged joints, unless otherwise specified or shown on the drawings.

E. The Drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

2.02 WALL PIPES

A. Where wall sleeves or wall pipes occur in walls that are continuously wet on one or both sides, they shall have water stop flanges at the center of the casting or as shown on the Drawings. Ends of wall pipes shall be flange, mechanical joint, plain end, or bell as shown on the Drawings, or as required for connection to the piping. Wall pipes shall be of the same material as the piping that they are connected to. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange. Unless otherwise shown on the Drawings, waterstop flanges shall conform to the minimum dimensions shown below:

Pipe Size	Waterstop Flange Diameter	Waterstop Flange Thickness
4" - 12"	OD + 3.10"	0.50"
14" - 24"	OD + 4.15"	0.75"
30" - 36"	OD + 4.50"	1.00"
42" - 48"	OD + 5.00"	1.25"
54"	OD + 5.90"	1.50"

2.03 SLEEVES

A. Unless shown otherwise, all piping passing through walls and floors shall be installed in sleeves or wall castings accurately located before concrete is poured, or placed in position during construction of masonry walls. Sleeves passing through floors shall extend from the bottom of the floor to a point 3 inches above the finished floor, unless shown otherwise. Water stop flanges are required on all sleeves located in floors or walls which are continually wet or under hydrostatic pressure on one or both sides of the floor or wall.

B. Sleeves shall be cast iron, black steel pipe, or fabricated steel in accordance with details shown on the Drawings. If not shown on the Drawings, the Contractor shall submit to the Engineer the details of sleeves he proposes to install; and no fabrication or installation thereof shall take place until the Engineer's approval is obtained. Steel sleeves shall be fabricated of structural steel plate in accordance with the standards and procedures of

AISC and AWS. Steel sleeve surfaces shall receive a commercial sandblast cleaning and then be shop painted in accordance with Section 09900S – Painting.

C. When shown on the Drawings or otherwise required, the annular space between the installed piping and sleeve shall be completely sealed against a maximum hydrostatic pressure of 20 psig. Seals shall be mechanically interlocked, solid rubber links, trade name "Link-Seal", as manufactured by the Thunderline Corp., Wayne, Michigan, or equal. Rubber link, seal-type, size, and installation thereof, shall be in strict accordance with the offeror's recommendations. For non-fire rated walls and floors, pressure plate shall be glass reinforced nylon plastic with EPDM rubber seal and 304 stainless steel bolts and nuts. For fire rated walls and floors, two independent seals shall be provided consisting of low carbon steel, zinc galvanized pressure plates, silicon rubber seals and low carbon steel, zinc galvanized bolts and nuts.

D. Cast iron mechanical joint adapter sleeves shall be Clow # 1429, as manufactured by the Clow Corp., or equal. Mechanical joint adapter sleeves shall be provided with suitable gasket, follower ring, and bolts to effect a proper seal. In general, sleeves installed in walls, floors, or roofs against one side of which will develop a hydrostatic pressure, or through which leakage of liquid will occur, shall be so sealed. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange.

2.04 SOLID SLEEVE COUPLINGS

A. Solid sleeve couplings shall be used to connect buried service piping where shown on the Drawings. Solid sleeves shall be ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Unless otherwise shown or specified, solid sleeve couplings shall be Style A11760 as manufactured by American Cast Iron Pipe Co., or equal.

2.05 FLEXIBLE COUPLINGS

A. Flexible couplings shall be as manufactured by the Red Valve Company and shall consist of a molded reinforced fabric of cotton and natural rubber. Galvanized steel retaining rings shall be furnished. End connections shall match ANSI 125 pound flanges with a minimum pressure rating of 140 psi.

2.06 SLEEVE TYPE COUPLINGS

A. Sleeve type, flexible couplings shall be furnished and installed where shown on the Drawings or otherwise required to resist internal operating pressures. In addition to that specified herein, harnessed, sleeve type flexible couplings shall be provided on all exposed pipe 3 inches and larger in diameter that spans any expansion joint in a building or structure.

B. Materials shall be of high strength steel and couplings shall be rated for the same pressures as the connecting piping.

C. Gaskets shall be rubber. Bolts and nuts shall be alloy steel, corrosion-resistant and prime coated.

D. Couplings shall be shop primed with a premium quality primer compatible with the painting system specified in Section 09900S - Painting. Field painting of wetted area shall be done prior to installation.

E. Harnessing

1. Harness couplings to adjacent flanges as shown, specified or otherwise required to restrain all pressure piping.

2. Dimensions, sizes, spacing and materials for lugs, tie rods, washers, and nuts shall conform to the standards for the pipe size, and design pressure specified.

3. No less than two (2) bolts shall be furnished for each coupling.

4. Tie bolts, nuts and washers shall be ASTM A 193, Grade B7 steel or better.

5. Harness rods shall have lengths less than 10 feet between adjacent flanged joints on fittings and shall be coated in accordance with Section 09900S – Painting.

F. Couplings shall be as manufactured by Dresser Industries, Style 38, or equal as required and shown on the Drawings. All couplings shall be provided without interior pipe stop.

2.07 FLANGED ADAPTERS

A. Flanged adapters shall be furnished as required and as shown on the Drawings.

B. All flanged adapters, 12 inches in diameter and smaller, except as shown on the Drawings or directed by the Engineer, shall be locking type flanged adapters.

C. Pressure and service shall be the same as connected piping.

D. Materials shall be cast iron for pipes up to 12 inch diameter and high strength steel for pipes larger than 12 inch diameter.

E. Flanged adapters shall be shop primed with a premium quality primer compatible with the paint system specified in Section 09900S – Painting. Field painting of wetted area shall be done prior to installation.

F. Bolts and nuts shall be alloy steel, corrosion-resistant and prime coated.

G. Flanged coupling adapters larger than 12 inches in diameter shall be harnessed by tying the adapter to the nearest pipe joint flange using threaded rods and rod tabs. The threaded rods and rod tabs shall be as shown on the Drawings.

H. Flanged adapters shall be as manufactured by Dresser Industries, Style 127 or 128, Smith Blair Corporation, or equal.

2.08 MECHANICAL COUPLINGS (SPLIT TYPE - SHOULDERED END)

A. Mechanical couplings (split type-shouldered end) shall be furnished as specified or shown on the Drawings.

B. Materials shall be of malleable iron and couplings shall be rated for the same pressures as the connecting piping.

C. Gaskets shall be rubber. Bolts and nuts shall be heat treated carbon steel track bolts and shall be plated.

D. After installation, buried couplings shall receive two heavy coats of an approved coal tar which is compatible with the finish of the coupling. Exposed couplings shall be painted in accordance with Section 09900S - Painting.

E. Couplings shall be as manufactured by Victaulic Company of America, Style 31, or equal.

2.09 TAPPING SLEEVES AND TAPPING SADDLES

A. Tapping sleeves shall be similar to Mueller Outlet Seal, American Uniseal or Kennedy Square Seal. All sleeves shall have a minimum working pressure of 150 psi. All sleeves larger than twelve (12) inches shall be ductile iron. All taps shall be machine drilled; no burned taps will be allowed.

B. Tapping saddles may be used on mains sixteen (16) inches and larger where the required tap size does not exceed one-half the size of the main (i.e. 8-inch tapping saddle for use on a 16-inch main). Tapping saddles shall be manufactured of ductile iron providing a factor of safety of at least 2.5 at a working pressure of 250 psi. Saddles shall be equipped with a standard AWWA C-110-77 flange connection on the branch. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddles. Straps shall be of alloy steel. The tapping saddle shall be the American tapping saddle, U.S. Pipe tapping saddle, or equal. All taps shall be machine cut, no burned taps will be allowed.

2.10 UNIONS

A. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.

B. For copper piping, unions shall have ground joints and conform to ANSI B16.18.

C. For PVC and CPVC piping, unions shall be socket weld type with Viton O-ring.

2.11 THERMOPLASTIC TUBING AND FITTINGS

A. Thermoplastic tubing shall be manufactured from polyallomor tubing. Tubing shall be protected from ultraviolet radiation degradation with a black coating or integral color conforming to ASTM D-1248, Type 1, Class C, Category 3. Fittings and connectors used with thermoplastic tubing shall be the flareless tube type constructed of brass conforming to SAE CA377, SAE CA360 or equal. Brass sleeves shall be used.

B. Assembly of the thermoplastic tubing shall consist of pushing the tubing into the fitting and hand tightening the nut with final tightening with a wrench. Care shall be taken not to overtighten the nut. Plastic tube racks and bend holders shall be provided for holding the tubing in position. Needle valves used with thermoplastic tubing shall be the globe type constructed with a brass body, stem and seat and Buna-N "O"-ring seals. Installation shall be in accordance with the offeror's recommendations. Thermoplastic tubing, shall be the Impolene (polyallomor) system and needle valves, fittings and connectors shall be the Poly-Flo with 261 UB Universal Nut and Sleeve system as manufactured by Imperial Eastman, or equal.

2.12 HEAT TRACED PIPING

A. Exposed pipes to be insulated shall also be protected from freezing by heat tracing. Freeze protection heat tracing shall consist of twin 16 AWG copper brass wires with a semiconductor polymer core where electrical resistance varies with temperature. The heat tracing shall have a fluoropolymer outer jacket for corrosion resistance. The heat tracing shall be rated for three (3) watts per foot output, self-regulating with a maximum temperature of 150°F, equal to a Chromalox No. SRL3-1CT383400. Maximum length for tape shall be 300 feet for each circuit. Temperature controller shall be provided to sense pipe temperature to determine on or off condition of the heat tracing. Temperature control shall be equal to a Chromalox No. RTBC-2-384729. The heat tracing system shall operate on 120 VAC. See Drawings for installation detail. Heat tracing of piping shall be provided as specified in Section 15390 – Schedules, which shall be included in the Specifications provided as part of the Expansion Project.

2.13 FLEXIBLE RESTRAINED EXPANSION JOINTS

A. Restrained expansion joints shall be manufactured of 60-42-10 ductile iron conforming to material and other applicable requirements of ANSI/AWWA C153/A21.53.

B. Each pressure containing component shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the materials requirements of, and tested in accordance with, ANSI/AWWA C213 and shall meet or exceed the requirements of ANSI/AWWA C550.

C. Seals shall conform to the applicable requirements of ANSI/AWWA C111/A21.11.

D. All bolts used in the assemblies shall be stainless steel and shall be coated with a premium quality epoxy.

E. Flanged ends shall comply with ANSI/AWWA C110/A21.10, with the addition of O-ring groove and O-ring.

F. Mechanical joint ends shall comply with ANSI/AWWA C153/A21.53.

G. Restrained expansion joints shall have a minimum pressure rating of 350 psi with a minimum safety factor of 3:1. Each assembly shall be tested at 350 psi before shipment.

H. Restrained expansion joints shall provide for self-restraint without tie rods and shall provide for expansion and contraction capabilities cast as an integral part of the end connection.

I. Flexible restrained expansion joints shall allow for 8-inches (+6"-2") minimum expansion.

J. Flexible restrained expansion joints shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint having a minimum of 15° deflection per ball.

K. Restrained expansion joints shall be the Single Ball or Double Ball FLEX-TEND Expansion Joint as manufactured by EBAA Iron Inc., or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe offeror. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping connections to equipment shall be provided with unions or coupling flanges located so that piping may be readily dismantled from the equipment. At certain applications, Dresser, Victaulic, or equal, couplings may also be used. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Unless otherwise shown or approved, provided a minimum headroom clearance under all piping of 7 feet 6 inches.

B. Unless otherwise shown or specified, all waste and vent piping shall pitch uniformly at a 1/4-inch per foot grade and accessible cleanouts shall be furnished and installed as shown and as required by local building codes. Installed length of waste and vent piping shall be determined from field measurements in lieu of the Drawings.

C. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. The minimum trench widths shall be in strict accordance with the "Trench Width Excavation Limits" as shown on the Drawings. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.

D. ALL EXCAVATION REQUIRED BY THIS CONTRACT SHALL BE UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE MADE FOR ROCK EXCAVATION REQUIRED FOR THE INSTALLATION OF PIPE OR STRUCTURES SHOWN ON THE DRAWINGS.

E. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

F. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.

G. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet. The Contractor shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the Engineer as to the condition and bearing value before any pipe is laid or bedding is placed.

H. No pressure testing shall be performed until the pipe has been properly backfilled in place. All pipe passing through walls and/or floors shall be provided with wall pipes or sleeves in accordance with the specifications and the details shown on the Drawings. All wall pipes shall be of ductile iron and shall have a water stop located in the center of the wall. Each wall pipe shall be of the same class, thickness, and interior coating as the piping to which it is joined. All buried wall pipes shall have a coal tar outside coating on exposed surfaces.

I. JOINT DEFLECTION SHALL NOT EXCEED 75 PERCENT OF THE MANUFACTURERS RECOMMENDED DEFLECTION. Excavation and backfilling shall conform to the requirements of Section 02200S - Earthwork, and as specified herein. Maximum trench widths shall conform to the Trench Width Excavation Limits shown on the Drawings. All exposed, submerged, and buried piping shall be adequately supported and braced by means of hangers, concrete piers, pipe supports, or otherwise as may be required by the location.

J. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. UNDER NO CIRCUMSTANCES SHALL ANY OF THE MATERIALS BE DROPPED OR DUMPED INTO THE TRENCH.

K. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.

L. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.

M. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.

N. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with offeror’s recommendations.

O. AT THE CLOSE OF EACH WORK DAY THE END OF THE PIPELINE SHALL BE TIGHTLY SEALED WITH A CAP OR PLUG SO THAT NO WATER, DIRT, OR OTHER FOREIGN SUBSTANCE MAY ENTER THE PIPELINE, AND THIS PLUG SHALL BE KEPT IN PLACE UNTIL PIPE LAYING IS RESUMED.

P. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.

Q. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used exceptions: closure pieces at manholes and areas where joint deflection is required.

R. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each manhole and any adjustments will be coordinated and approved by the Engineer.

S. ALL PIPING SHALL HAVE TYPE "A" BEDDING AS SHOWN ON THE DRAWINGS, UNLESS OTHERWISE SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS.

T. Detector tape shall be installed 12 inches below final grade and directly above all buried potable water piping. The tape shall be blue and silver and shall be clearly and permanently labeled "Water". Detector tape shall be Lineguard III as manufactured by Lineguard, Inc., or equal.

U. AT THE CLOSE OF WORK EACH DAY PIPELINE TRENCHES SHALL BE COMPLETELY BACKFILLED. IN PAVED AREAS THE SURFACE SHALL BE RESTORED AS SPECIFIED IN SECTION 02510S, PAVING AND SURFACING, TO ALLOW FOR TRAFFIC OVER THE TRENCH DURING NON-WORKING HOURS. UNDER NO CONDITIONS SHALL ANY PIPELINE TRENCH BE LEFT OPEN DURING NON-WORKING HOURS.

NOTE: STANDARD BEDDING CONDITION IS SPECIFIED ABOVE - ADD ANY SPECIAL BEDDING CONDITIONS HERE. VERIFY THAT PROPER DETAILS APPEAR ON DRAWINGS.

3.02 REINFORCED CONCRETE PIPE, CONCRETE CULVERT, AND DRAIN PIPE

A. The laying of reinforced concrete pipe shall conform to the applicable sections of the Concrete Pipe Handbook as published by the American Concrete Pipe Association.

3.03 PRESTRESSED CONCRETE PIPE

A. The laying of prestressed concrete pipe shall be in accordance with the manufacturer's recommendations and shall conform to the applicable sections of AWWA Manual M-9. Prior to assembling the spigot end into the bell end, both ends shall be thoroughly cleaned and the rubber gasket and the bell end of the previously laid pipe shall be coated with vegetable soap furnished by the manufacturer.

B. For each crew that is inexperienced in laying this type of pipe, one reliable man shall be furnished by the manufacturer's representative with and instructed in the use of a set of steel inserts and feeler gauge to be used in determining if the rubber gasket is in proper position prior to the joint being pushed or pulled home. An experienced crew may omit the use of a feeler gauge. In either method of operation, the Contractor shall be responsible for a good, proper and sound joint. Any joint found in later tests to be faulty shall be repaired to the satisfaction of the Engineer.

C. After the pipe is "home" a cloth diaper (minimum 7-inches wide) supplied by the pipe manufacturer shall be placed and wired around the outside of the pipe at the joint. This diaper shall serve as a form for pouring a 1:2 cement-sand grout in the external recess.

D. Great care shall be taken to prevent the concrete core or jacket or the steel bell and spigot rings from being damaged, and any core, jacket or ring damaged in any way shall be repaired or replaced by the Contractor to the satisfaction of the Engineer.

3.04 DUCTILE IRON PIPE

A. Ductile iron pipe (DIP) shall be installed in accordance with the requirements of the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association, and AWWA C600.

B. Where it is necessary to cut ductile iron pipe in the field, such cuts shall be made carefully in a neat workmanlike manner using approved methods to produce a clean square cut. The outside of the cut end shall be conditioned for use by filing or grinding a small taper, at an angle of approximately 30 degrees.

C. UNLESS OTHERWISE APPROVED BY THE ENGINEER, FIELD WELDING OF DUCTILE IRON WILL NOT BE PERMITTED.

3.05 PVC/CPVC AND HDPE PIPE

A. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC) and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.

B. Plastic piping shall not be installed when the temperature is less then 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

3.06 CARBON AND STAINLESS STEEL PIPE

A. Installation of steel pipe shall be by skilled workmen and shall conform to the applicable sections of AWWA Manual M-11. Joints for steel piping shall be either screwed, welded, or flanged as shown on the Drawings or as specified.

B. Welding in the field shall be performed only when requested on the shop drawings and permitted by the Engineer for carbon steel pipe. No welding of stainless steel pipe shall be allowed in the field. All field welds shall be radiographically inspected.

C. Installation of the steel casing pipe shall be by skilled workmen and in accordance with the best standard practice for steel pipe installation. Joints for steel casing pipe shall be butt welded.

1. The boring equipment to be used for installing the jacked casing shall be of such size and capacity to allow the boring to proceed in a safe and expeditious manner. The installation of the casing and boring of the hole shall be done simultaneously to avoid cave-ins or settlement and for safety of traffic above.

2. The Contractor shall check the vertical and horizontal alignment of the casing by survey instrument at least once during each four feet of advance, or as directed by the Engineer. Pits shall be well sheeted and braced as necessary for safe and adequate access for workmen, inspectors and materials and shall be of a size suitable to equipment and material handling requirements.

3. Under no conditions shall jetting or wet boring of encasement under pavement be allowed.

4. After installation of the carrier pipe, each end of the casing pipe shall be made watertight with a brick masonry bulkhead. In addition, a Class B concrete cradle shall be provided from each end of the bulkhead to the first pipe joint outside of the bulkhead.

3.07 COPPER PIPE

A. Installation of copper pipe shall be by skilled workman in accordance with the manufacturer's recommendations. Use teflon tape at all fittings unless otherwise required for intended service. Install unions at the connections to each piece of equipment to allow removal of equipment without dismantling connecting piping.

B. Wall sleeves shall be provided for all piping passing through exterior walls and shall be of the same material as the piping to which it is joined. All wall sleeves shall be provided with an acceptable waterstop.

C. The Contractor shall provide hot and cold water mains with branches and risers complete from point indicated on the Drawings running to all fixtures and other outlets indicated. Mains and branches shall be run generally as shown on the Drawings. The Contractor shall provide all interior water piping, branches, and risers as shown on the Drawing and shall make connections to all plumbing fixtures, hose bibs, wall hydrants, and other points requiring water under this and other Divisions of the Specifications.

D. All water mains and branches shall be pitched at least one (1) inch in twenty-five (25) feet toward fixtures. The piping installation shall be arranged so that the entire system can be drained through fixture supply connections.

E. Unions shall be installed at the connections to each piece of equipment to allow for removal of equipment without dismantling connecting piping.

F. Joints 1-1/4 inches and larger shall be made with silver solder. For joints less than 1-1/4 inches and all valves (regardless of size) use 95/5 solder. Soldered joints shall be prepared with a non-corrosive paste flux in accordance with manufacturer's instructions. All joints shall be thoroughly cleaned with emery cloth and reamed out before assembly. Acid core solder will not be permitted.

3.08 POLYPROPYLENE AND POLYVINYLIDENE FLUORIDE PIPE

A. The pipe and fittings shall be of the same material for both inner and outer walls of the pipe.

B. Polypropylene pipe shall be black UV stabilized co-polymer conforming to the requirements of ASTM D-4101. Where used in exterior locations, material shall provide a weathering resistance absent of further coating, covering, or wrapping unless specified herein or shown on the Drawings.

C. Polyvinylidene flouride shall comply with ASTM D-3222. The material shall provide a translucence, thus enabling a visual inspection of liquid in the annular space between the inner and outer walls.

D. Where elastomers are selected by the manufacturer, such selection shall be with regard to the application of the chemical solution to be transported.

E. Pipe and associated fittings shall be rated for not less than 75 psi at 73°F.

F. Double-walled pipe and fittings shall be molded and used throughout. Molded ribs shall maintain permanent alignment of the inner and outer walls of the pipe and fittings.

G. Ends of fittings shall be flush, creating a single plane.

H. Wall thickness of the inner and outer walls of double-walled pipe shall be identical, providing identical pressure ratings.

I. Where shown on the Drawings, a leak detection system of the manufacturer's design shall be supplied, complete with vent pipes, manual drain outlet, and electric float switch. Switch shall be rated for 0.080 amps at 120 VAC.

J. Polypropylene and polyvinylidene flouride pipe shall be laid and joints assembled by skilled workers according to the respective manufacturer's recommendations. Joints shall be butt fusion welded.

K. Plastic piping shall not be installed when the ambient temperature is less than 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

L. Wall sleeves shall be provided where piping passes through exterior walls. All sleeves shall be provided with an acceptable waterstop.

M. Double walled pipe shall be Asahi/American or equal. Pipe shall be furnished complete with flanges or other appurtenant fittings by the same manufacturer and made especially for use with the double walled pipe.

3.09 JOINTS IN PIPING

A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.

B. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed and the condition corrected.

C. Flanged joints shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places. Bolts or studs shall be uniformly tightened around the joints. Where stud bolts are used, the bolts shall be uniformly centered in the connections and equal pressure applied to each nut on the stud. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.

D. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution of mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.

E. Threaded and/or screwed joints shall have long tapered full depth threads to be made with the appropriate paste or jointing compound, depending on the type of fluid to be processed through the pipe. All pipe up to, and including 1-1/2-inches, shall be reamed to remove burr and stood on end and well pounded to remove scale and dirt. Wrenches on valves and fittings shall be applied directly over the joint being tightened. Not more than three pipe threads shall be exposed at each connection. Pipe, in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot. Joints in all piping used for chlorine gas lines shall be made up with a glycerine and litharge cement. Joints in plastic piping (PVC/CPVC) shall be laid and joints made with compounds recommended by the manufacturer. Installation shall conform to the requirements of ASTM D2774 and ASTM D2855. Unions required adjacent to valves and equipment.

F. Soldered joints shall have the burrs removed and both the outside of pipe and the inside of fittings shall be thoroughly cleaned by proper tools recommended for that purpose. Flux shall be applied to both pipe and inside of fittings and the pipe placed into fittings and rotated to insure equal distribution of flux. Joints shall be heated and solder applied until it shows uniformly around the end of joints between fitting and pipe. All joints shall be allowed to self-cool to prevent the chilling of solder. Combination flux and solder paste manufactured by a reputable manufacturer is acceptable. Unions required adjacent to valves and equipment.

G. Welded joints shall be made by competent operators in a first class workmanlike manner, in complete accordance with ANSI B31.1 and AWWA C206. Welding electrodes shall conform to ASTM A233, and welding rod shall conform to ASTM A251. Only skilled welders capable of meeting the qualification tests for the type of welding which they are performing shall be employed. Tests, if so required, shall be made at the expense of the Contractor, if so ordered by the Engineer. Unions shall be required adjacent to valves and equipment.

H. Copper joints shall be thoroughly cleaned and the end of pipes uniformly flared by a suitable tool to the bevels of the fittings used. Wrenches shall be applied to the bodies of fittings where the joint is being made and in no case to a joint previously made. Dimensions of tubing and copper piping shall be in complete accordance with the fittings used. No flare joints shall be made on piping not suited for flare joints. Installations for propane gas shall be in accordance with NFPA 54 and/or 58.

I. Solvent or adhesive welded joints in plastic piping shall be accomplished in strict accordance with the pipe manufacturer's recommendations, including necessary field cuttings, sanding of pipe ends, joint support during setting period, etc. Care shall be taken that no droppings or deposits of adhesive or material remain inside the assembled piping. Solvent or adhesive material shall be compatible with the pipe itself, being a product approved by the pipe manufacturer. Unions are required adjacent to valves and equipment. Sleeve-type expansion joints shall be supplied in exposed piping to permit 1-inch minimum of expansion per 100 feet of pipe length.

J. Dielectric unions shall be installed wherever dissimilar metals are connected except for bronze or brass valves in ferrous piping. Unions shall be provided downstream of each valve with screwed connections. The Contractor shall provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

K. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

L. Joints in polypropylene and polyvinylidelene fluoride pipe shall be butt fusion weld. All butt welding shall follow the requirements of ASTM D-2657 and the manufacturer's recommendations.

3.10 FLUSHING AND TESTING

A. All piping shall be properly flushed and tested unless specifically exempted elsewhere in the Specifications or otherwise approved by the Engineer. Air and gas pipelines shall be flushed and tested with compressed air. Gravity sewer piping shall be flushed and tested as specified in Section 02604S - Utility Structures. All other liquid conveying pipelines shall be flushed and tested with water. The Contractor shall furnish and install all means and apparatus necessary for getting the air or water into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be flushed and tested in such lengths or sections as agreed upon among the Owner, Engineer, and Contractor. Test pressures shall be as specified in Section 15390 – Schedules, and shall be measured at the lowest point of the pipe segment being tested. The Contractor shall give the Owner and Engineer reasonable notice of the time when he intends to test portions of the pipelines. The Engineer reserves the right, within reason, to request flushing and testing of any section or portion of a pipeline.

B. The Contractor shall provide water for all flushing and testing of liquid conveying pipelines. Raw water or non-potable water may be used for flushing and testing liquid pipelines not connected to the potable water system. Only potable water shall be used for flushing and testing the potable water system.

C. Air and gas piping shall be completely and thoroughly cleaned of all foreign matter, scale, and dirt prior to start-up of the air or gas system.

D. At the conclusion of the installation work, the Contractor shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period. If after this cleaning any obstructions remain, they shall be corrected by the Contractor, at his own expense, to the satisfaction of the Engineer. Liquid conveying pipelines shall be flushed at the rate of at least 2.5 feet per second for a duration suitable to the Engineer or shall be flushed by other methods approved by the Engineer.

E. Compressed/service air and gas piping shall be flushed by removing end caps from the distribution lines and operating one (1) compressor, in accordance with the manufacturer's instructions.

F. After flushing, all air piping shall be pressure and leak tested prior to coating and wrapping of welded joints. Immediately upon successful completion of the pressure and leak test, welded joints shall be thoroughly cleaned of all foreign matter, scale, rust, and discoloration and coated in accordance with the Specifications.

G. All process air piping shall be leak tested by applying a soap solution to each joint. Leak tests shall be conducted with one (1) blower in service at normal operating pressure.

H. During testing the piping shall show no leakage. Any leaks or defective piping disclosed by the leakage test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

I. All buried process air piping shall be pressurized to 25 psig and tested for leaks by applying a soap solution to each joint. The air supply shall be stopped and the pipe pressure monitored. System pressure shall not fall by more than 0.5% of the 25 psig test pressure over a one-hour test period. Should the system fail to hold the required pressure for one hour, the cause shall be determined and corrected and the test repeated until a successful test of the entire system is obtained.

J. Field leakage tests shall be performed for all submerged process air piping. The procedure shall consist of operating the system under clear nonpotable water for visual identification of all leaks. All field leakage tests shall be witnessed by the Engineer. All submerged piping shall be installed free of any leaks.

K. After flushing, all liquid conveying pipelines shall be hydrostatically tested at the test pressure specified in the appropriate Piping System Schedule in Section 15390 – Schedules. The procedure used for the hydrostatic test shall be in accordance with the requirements of AWWA C600. Each pipeline shall be filled with water for a period of no less than 24 hours and then subjected to the specified test pressure for 2 hours. During this test, exposed piping shall show no leakage. Allowable leakage in buried piping shall be in accordance with AWWA C600.

L. Any leaks or defective pipe disclosed by the hydrostatic test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

M. After flushing, all gas piping shall be leak tested in accordance with all local codes and regulations and in conformance with the recommendations or requirements of any National Institute or Association for the specific service application.

3.11 DISINFECTION

A. All pipe and fitting connected to and forming a part of a potable water supply shall be disinfected in accordance with the procedures described in AWWA C 651. Disinfection shall also be in accordance with the requirements of the Virginia Department of Environmental Quality and the Owner.

B. Disinfection shall be accomplished after the pipe has been flushed, if applicable, and passed the hydrostatic test. Such piping shall be filled with 50 parts per million (PPM) of chlorine and held in contact for not less than 24 hours. Final tests after 24 hours contact time shall show a minimum residual chlorine content of 10 ppm in all parts of the system. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or Virginia DEQ and/or the Owner until the minimum residual chlorine content of 10 ppm has been reached. The Contractor shall obtain certificates of satisfactory bacteriological tests and furnish them to the Owner before the request is made for acceptance of the work. The Contractor shall furnish and install, at his own expense, all means and apparatus necessary for performing the disinfection. The chlorine solution shall be thoroughly flushed out prior to placing the new sections of pipe in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant, or fish life. Chlorine residual tests will be made after flushing to assure that residual is not in excess of 1 ppm at any point in system.

3.12 PAINTING AND COLOR CODING SYSTEM

A. All exposed piping specified shall be color coded in accordance with the Owner's standard color designation system for pipe recognition and in accordance with Section 15030S – Piping and Equipment Identification Systems. In the absence of a standard color designation system, the Engineer will establish a standard color designation for each piping service category from color charts submitted by the Contractor in compliance with Section 09900S – Painting.

B. All piping specified in this Section shall be painted in accordance with Section 09900S – Painting, except as follows:

1. Copper pipe

2. Stainless steel pipe. Flanges and supports or hangers shall be painted.

- END OF SECTION -

SECTION 15013S

STEEL PIPE FOR LOW PRESSURE PROCESS AIR SERVICE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. This specification shall apply to steel and stainless steel pipe for low pressure air service (less than 25 psig).

B. The AWWA Specifications referenced in this section are supplemented as follows:

1. The steel manufacturer's certification that the material meets the ASTM Specification will be accepted in lieu of tests on specimens taken from the fabricated pipe.

2. The fabricator may purchase steel plates on the chemical basis only and shall furnish to the Owner certified test reports.

3. Joints shall be welded unless otherwise indicated on the Drawings.

C. All parts of the materials furnished shall be amply designed, manufactured, and constructed for the maximum stresses occurring during fabrication, erection and operation. All materials shall be new and both workmanship and materials shall be of the very best quality, shall be entirely suitable for the service to which they will be subjected, and shall conform to all applicable sections of these Specifications. Manufacturer's designs shall accommodate all of the requirements of these Specifications.

D. The Offeror shall be responsible for the structural design of the steel and stainless steel pipe, fittings, and couplings. The Offeror shall submit certification that the steel and stainless steel pipe, fittings, and couplings have been designed to resist all loads implied and reasonably anticipated.

E. Reference Section 15000S – Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 STAINLESS STEEL PIPE AND FITTINGS

A. Stainless steel pipe for process aeration and other low pressure air service for nominal pipe sizes ranging from three (3) inches to sixty (60) inches shall be manufactured from 316L stainless steel annealed and pickled sheets and plates per ASTM A240.

B. Stainless steel pipe shall be fabricated in accordance with ASTM A778 and shall be rated for at least 25 psig and 300 degrees Fahrenheit (°F). Only seamless or one (1) longitudinal seam shall be permitted unless otherwise required for fabrication of large diameter pipe in accordance with ASTM A774. Only stainless steel pipe shall be provided; tubing shall not be allowed. Stainless steel pipe shall be as manufactured by Douglas Brothers, Felker Bros. Corp., or Engineer approved equal.

C. Stainless steel pipe shall be manufactured to the nominal pipe sizes as listed in ANSI B36.19, Table 2, and shall have the following minimum wall thicknesses:

Nominal Pipe Size (inches)	**Schedule/Gauge/Plate**
4 and less	Schedule 5S (0.083-inch)
5 to 8	Schedule 5S (0.109-inch)
10 to 12	12 gauge (0.109-inch)
14 to 18	11 gauge (0.125-inch)
20	10 gauge (0.140-inch)
24 to 36	0.187-inch
42 to 48	0.250-inch
54 to 60	0.312-inch

D. Fittings shall be fabricated from the pipe specified and shall conform to ASTM A774, unless otherwise shown on the Drawings or required for proper installation.

E. Flanges where shown on the Drawings shall be a lap joint flange assembly consisting of a 316L stainless steel slip-on rolled angle ring with a 316L stainless steel drilled backup flange conforming to ASTM A240, and shall conform dimensionally to ANSI B16.1, Class 125. The leg of the angle ring shall not interfere with the flange bolt holes. Alternately, slip-on plate flanges conforming to ANSI B16.1, Class 125 are acceptable at specific locations as approved by the Engineer. The plate flange shall be continuously welded to the pipe. The backup flanges and plate flanges shall be supplied with the following nominal thicknesses:

Nominal Pipe Size (inches)	**Flange Thickness (inches)**
2-1/2 to 3	1/2
4	9/16
6 to 10	5/8
12 to 16	3/4
18 to 20	7/8
24 to 30	1
36	1-1/8
42	1-1/4
48	1-3/8
54	1-3/8
60	1-1/2

F. Bolts for flanged joints shall be of the size and length called for and in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. Bolts shall be per ANSI B18.2, stainless steel, type and grade to prevent galling. Bolts shall have hexagonal heads and nuts; no washers shall be used. Bolts used at all transitions to material other than stainless steel shall be furnished with dielectric insulation material service rated for 300 degrees Fahrenheit continuous service at 25 psig.

G. Gaskets for flanged joints shall be Viton or silicone material, “Ring-Gasket” type, 1/8-inch minimum thickness, and suitable for 300 degrees Fahrenheit continuous service at 25 psig. Dielectric gaskets shall be used at all transitions to material other than stainless steel. Segmented gaskets will not be acceptable.

H. Joints in piping 3 inches in diameter or larger shall be butt welded or flanged, unless otherwise shown on the Drawings. Joints in piping less than 3 inches in diameter shall be threaded, unless otherwise shown on the Drawings.

I. Welding practices for joints shall conform to those specified for the manufacture of the pipe and fittings in ASTM A774 and A778, and the specifications contained herein. All welds shall be free from burrs, snags, or rough projections.

J. Welding shall be performed by AWS-certified welders in conformance with standard procedures. Piping with wall thickness up to 11 gauge (0.125-inch) shall be welded with the TIG (GTAW) process. Heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler wire of ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping or fittings. Concavity, undercut, cracks, or crevices shall not be allowed. Butt-welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding. Angle face rings shall be continuously welded on both sides to the pipe or fitting. Welds on gasket surfaces shall be ground smooth.

K. All fittings shall be welded with 316L filler metal. All elbows through 24-inch size shall be long radius, die-formed, and shall be automatically butt welded in accordance with ASTM A774 of the same material and thickness as the pipe using gas tungsten-arc procedures with inert gas backing. Tees, crosses, true wyes, and laterals shall be shop-fabricated. All short radius, special radius, and reducing elbows and long radius elbows greater than 24-inch shall be mitered construction with at least (5) miter sections for 90-degree bends, (3) mitered sections for 45-degree and 60-degree bends, and (2) mitered sections for 30-degree and smaller bends. All reducers shall be straight tapered, cone-type. Longitudinal welds on all fittings, except elbows, shall be accomplished by the same procedures as listed for pipe. Weld seams shall have full penetration and be free of oxidation, crevices, pits, cracks, and protrusions. Fitting dimensions shall be in accordance with ANSI B16.9 and shall be terminated and dimensioned as indicated on the Drawings.

L. Pipe spools shall be manually welded with 316L filler metal using gas tungsten-arc procedures with internal gas purge where internal weld seams are not accessible. Where they are accessible, seams shall be welded both inside and outside using manual shielded metal-arc procedures. Weld seams shall have full penetration and shall be free of oxidation, crevices, pits, cracks, and protrusions.

M. All pipe, fittings, and spools shall be completely pickled and passivated by immersion in a nitric-hydrofluoric bath at the proper temperature and length of time to insure removal of all free iron, weld scale, and other impurities and to ensure the establishment of a passive surface. A clean water rinse shall follow the acid pickle.

N. The inspection of all welds shall be required. This shall be a visual inspection for crevices, pits, cracks, protrusions, and oxidation deposits. Presence of any of these items found in the weld seams shall be considered as grounds for rejection of the joint.

O. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks shall be located on the spools at opposite ends and 180 degrees apart.

P. The piping supplier during manufacturing, fabrication, and handling stages and the Contractor during handling and installation stages shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. Only manufacturer recommended saws, drills, files, wire brushes, etc. shall be used for stainless steel piping. Pipe storage and fabrication racks shall be non-ferrous or stainless steel or rubber-lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes, and rinse clean.

2.03 PROCESS AIR PIPE SUPPORT AND EXPANSION/CONTRACTION SYSTEM

A. The process air pipe support and expansion/contraction system shall include fixed supports, sliding supports, and expansion joints. Expansion joints shall be either a split sleeve expansion coupling or a metal bellows expansion joint as indicated on the Drawings. A metal bellows expansion joint shall be provided for all expansion joints, unless otherwise indicated on the Drawings.

B. The air pipe support and expansion/contraction system shall consist of expansion joints at the locations shown on the Drawings, with one fixed support between each pair of expansion joints. Fixed support details shall be as shown on the Drawings. Additional air pipe supports shall be sliding supports as shown on the Drawings and according to the support spacing requirements indicated and/or scheduled on the Drawings. Sliding and fixed support details shall be as shown on the Drawings.

C. Expansion couplings shall be bolted split-sleeve Style 231S as manufactured by Victaulic Company, or equal. Couplings shall be installed where shown on the Drawings and as specified in the following table, in accordance with the manufacturer’s recommendations for the specific application. Expansion couplings shall be provided at each insert flow tube. Initial gap width (space between plain ends of joining pipes) shall be set based on recommendations from the manufacturer. The body “type” shall be as required to meet the working pressure indicated.

Nominal Pipe Size (inch)	Coupling	Width “W” (inch)	Longitudinal Movement (C/E) (inch)
3 to 4	Type 1 Style 231 S	5.25	0.75
6	Type 1 Style 231 S	8	1.25
8 to 14	Type 1 Style 231 S	10	1.50
16 to 24	Type 1 Style 231 S	14.38	2.00
30 to 48	Type 2 Style 231 S	14.38	2.00
Greater than 48	Type 2 Style 231 S	16.38	3.00

1. Couplings shall be suitable for a pressure of 25 psig and a temperature of 300 degrees Fahrenheit, at minimum. The design “delta” or change in temperature shall be a minimum of 250 degrees Fahrenheit.

2. Couplings shall be bolted, split-sleeve type and shall consist of four components: one-piece housing, gasket assembly, bolts and nuts, and end rings as required for pipe restraint. Gasket material shall be Viton or silicone.

3. Couplings shall be manufactured from Type 316L stainless steel using 316 stainless steel bolts and nuts with a minimum tensile strength of 85,000 psi. End rings shall be Type 316L stainless steel. End rings shall be shop-welded to one end of one pipe installed in the coupling.

4. Couplings shall be provided and installed as specified and shown on the Drawings.

5. The gap, “G”, between ends of pipe shall be initially set and installed based on width of required clear space and the ambient temperature at the time of installation in conformance with requirements provided by manufacturer accounting for the required design movement allowance as specified for contraction and expansion of pipe.

D. All other air pipe expansion joints and/or where indicated on the Drawings shall be stainless steel bellows type expansion joints by DME Incorporated, Hyspan Precision Products, Inc., Omniflex by Victaulic, or equivalent coupling by U.S. Bellows, Inc., as specified and indicated on the Drawings. Laying lengths of expansion joints vary according to manufacturer. Lengths of expansion joints shown on the Drawings are approximate. Contractor shall provide dimensioned layout drawings for air piping based on the expansion joints ultimately furnished.

1. Expansion joints shall be metal bellows type with fixed flanged end preparations with a stainless steel internal flow liner. The joints shall provide for a minimum of 2 inches of axial movement in either direction for air pipe sizes 4 to 6 inches in diameter and a minimum of 3.5 inches of axial movement in either direction for all pipe sizes 8 inches and larger. Joints shall provide for a minimum lateral movement of 1/2 inch for all sizes. Number of convolutions shall be determined by the manufacturer based on movement requirements specified and a cycle life of 2,000 or more. The flanges shall meet the same thickness and class requirements as required for the joining stainless steel pipe.

2. Joints shall be suitable for a pressure of 25 psig and a temperature of 300 degrees Fahrenheit, at a minimum. The design “delta” or change in temperature shall be a minimum of 250 degrees Fahrenheit.

3. Joint and flanges shall be manufactured from Type 316L stainless steel using Type 316 stainless steel bolts and nuts with a minimum tensile strength of 85,000 psi. Coupling shall have an air service liner welded on the upstream side of the bellows.

4. The length of bellows, number of convolutions, and spacing between flanges shall be designed and installed accounting for the ambient temperature at the time of installation, which shall accommodate the full range of expansion and contraction movements as specified.

5. Required “cycle life” shall be a minimum of 2,000 based on “Expansion Joint Manufacturers Association” (EJMA) criteria, 10th Edition or later.

6. Metal bellows expansion joints shall be restrained using limit rods bolted between flange tabs. All material shall be Type 316L stainless steel. The limit rods and connecting tabs, including flanges, shall be designed by the manufacturer for the maximum loading condition.

7. Joints required for buried pipe shall be installed within a handhole or manhole as indicated on the Drawings. No backfill of any nature or material shall be placed against, under or over the joint.

PART 3 -- EXECUTION

3.01 FIELD WELDING OF STAINLESS STEEL PIPING AND FITTINGS

A. Offeror shall minimize the amount of field welding of steel and stainless steel piping required. Locations for pipe field welding will be evaluated and allowed on a case-by-case basis upon written approval of the Engineer. All field welding of steel and stainless steel pipe is subject to the following requirements:

1. Welding shall be performed by AWS-certified welders in conformance with AWS 1.6. Submit welder’s certification for approval prior to performing any field welding.

2. Piping with wall thickness up to 11 gauge (0.125-inch) shall be welded with the TIG (GTAW) process. Heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW) or MIG (GMAW) process. Filler wire of ELC grades only shall be added to all welds to provide a cross-section at the weld equal to or greater than the parent metal. Weld deposit shall be greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping or fittings. Concavity, undercut, cracks, or crevices shall not be allowed. Butt-welds shall have full penetration to the interior surface. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding.

3. Jigs shall be utilized to align adjacent sections of piping.

B. Post-Weld Treatment:

1. All field welds shall be wire brushed utilizing steel or stainless steel wire brushes to remove slag and spatter. Stainless steel brushes shall be used on stainless steel pipe.

2. The weld and the heat affected area shall be pickled with a brush-on pickling gel in accordance with ASTM A380 to remove all weld residue, oxide, and heat stain from the field weld and affected areas.

3. Pickling of stainless steel pipe shall be done in accordance with pickling paste manufacturer's directions, and areas being pickled shall be protected from direct sunlight. After pickling period is complete, neutralize pickling gel in accordance with directions and rinse area clean.

C. Where field welding of steel (carbon or stainless) piping is approved by the Engineer, <u>all</u> field welds shall be visually inspected and tested by an approved quality assurance testing firm in accordance with AWS D1.1, AISC Design Guide 21 Welded Connections, Section 9.0 and other applicable referenced sections of AWS and AISC. The Contractor shall be responsible for contracting with an approved testing firm. Nondestructive testing methods shall be used unless otherwise approved by the Engineer. The Contractor shall submit a proposed testing firm and personnel for approval in addition to his proposed plan to visually inspect and test all field welds of steel pipe prior to field welding of steel pipe.

3.02 FLUSHING AND TESTING

A. Flushing and testing of all installed low pressure air piping shall be performed as specified in Section 15000S – Basic Mechanical Requirements. The field testing procedure for process air piping shall use air pressure only.

- END OF SECTION -

SECTION 15020S

PIPE SUPPORTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and design calculations required to provide pipe supports in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01350 – Seismic Anchorage and Bracing

B. Division 3, Concrete – Appropriate and Related Sections

C. Section 05010S – Metal Materials

D. Section 05035 – Galvanizing

E. Section 05050S – Metal Fastening

F. Section 05061S – Stainless Steel

G. Section 05120S – Structural Steel

H. Section 05500S – Metal Fabrications

I. Section 05830S – Bearing Devices and Anchoring

J. Section 15000S – Basic Mechanical Requirements

1.02 SUBMITTALS

A. Applicable and associated cut sheets and drawings for materials and support components shall be submitted with the Shop Drawings in accordance with or in addition to the submittal requirements specified in Section 01302S – Submittals: Section 15000S - Basic Mechanical Requirements and other referenced Sections above.

1. Catalog cut information on all system components such as pipe supports, hangers, guides, anchors, and channel-type supports.

2. Drawings of the piping support systems, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide and anchor type by catalog number and Shop Drawing detail number.

3. With each piping support system Shop Drawing, the Offeror shall attach calculations prepared and sealed by a Professional Engineer licensed in the Commonwealth of Virginia, showing that the piping support system complies with the specified requirements, including all building code requirements pertaining to

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support of piping and other non-structural components.

4. Table showing the manufacturer's recommended hanger support spacing for PVC, CPVC and FRP pipe for the services listed in Section 15390 – Schedules which shall be included in the Specifications as part of the Expansion Project.

1.03 QUALITY ASSURANCE

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Professional Engineer licensed in the Commonwealth of Virginia.

PART 2 – PRODUCTS

2.01 GENERAL

A. The Contractor shall be responsible for the design of all piping support systems not specifically designed by the Engineer and detailed on the Drawings. The supports typically detailed on the Drawings, not included on Standard Detail Drawings, are designed to resist resulting external thrust forces in addition to gravity, seismic and other applicable loads required by the governing building code.

B. No attempt has been made to show all of the required pipe supports either on the main Drawings or on the standard detail drawings. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility of providing them throughout the project at no additional cost to the Owner.

C. Where special pipe support fabrications are required, products and execution shall be as specified in Section 05500S - Metal Fabrications and other related and referenced Sections of the Specifications.

D. Existing piping support systems to support new piping shall only be used if the Contractor can show and demonstrate by submitting supporting calculations that they are adequate for the additional load imposed by the new piping, or if they are strengthened to support the additional load.

E. Design Criteria for Piping Support Systems:

1. Design pipe supports for dead loads imposed by the weight of the pipes filled with water, except for air and gas pipelines, plus the weight of insulation. If applicable by location, ice loads per code shall be applied as indicated in the governing building code.

2. Design for the thermal expansion and contraction of the piping and its associated pipe support and pipe expansion systems and couplers.

3. Design the pipe supports for all seismic loading requirements and conditions as specified in the governing building code and referenced seismic design codes. Refer to Section 01350 - Seismic Anchorage and Bracing and the structural code drawing for seismic design criteria to be used for this project.

4. A minimum safety factor of 2 or as approved by the Engineer, based upon the yield strength of the support material, shall be used for pipe supports, braces, hangers, and guides as well as for beam and column members used in channel-type support systems.

5. The horizontal pipe hanger and/or floor support spacing shall be as recommended by the pipe and/or hanger manufacturer, but shall not exceed 10 feet on center unless indicated otherwise herein or on the Drawings.

6. Seismic and sway bracing shall be provided at maximum 10-foot centers.

7. The design, sizing and spacing of anchor bolts, including concrete anchors, shall be based on withstanding shear and pullout loads imposed by loading at each support. The minimum anchor bolt size shall be ½ inches in diameter. Refer to Section 05830S – Bearing Devices and Anchoring.

2.02 HANGERS AND SUPPORTS

A. All piping shall be adequately supported and braced by means of steel hangers and/or supports, concrete piers, supplemental lateral bracing components, pre-fabricated brackets, or otherwise as may be required by the location and forces applied per governing code, including gravity and lateral forces from earthquake and/or wind (if exterior). Generally, concrete supports shall be used where pipe centerline is less than 3 feet above floor, and hangers above 6 feet unless specified or shown otherwise. Supports shall be not more than 10 feet on center for steel and cast iron, 5 feet on center for plastic unless otherwise shown on the Drawings or required by the specific manufacturer. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing hangers and supports to the structure. Refer to Standard Detail Drawings.

1. Metal pipe support materials, where stainless steel pipe is supported, shall be Type 316 stainless steel meeting the requirements of Section 05061S - Stainless Steel.

2. Metal pipe support materials, where carbon steel, ductile or other ferrous pipe is supported, shall be galvanized carbon steel meeting Section 05120S - Structural Steel and Section 05035 - Galvanizing unless indicated otherwise on the Drawings or in the specifications or by the Engineer.

3. Metal pipe supports indicated as standard type pipe hangers are designed and detailed for gravity loading only. Resulting lateral loads from wind, earthquake, or other lateral loads per code, or special loading conditions during construction, shall be applied to the pipe in accordance with the governing building code. Supplemental lateral stiffening members (when necessary) shall be provided along pipe or at gravity supports using appropriate supplemental members and connections when required by calculations. The Contractor shall include design calculations and details with all pipe hangar and support submissions for review by the Engineer. The main structure and structural components that will support the pipe hangers and other appurtenant components of the facility have been designed to resist all resulting secondary lateral loading from pipe hangers and other non-structural members for gravity and resulting lateral loads.

B. Hangers and supports shall conform to the following requirements:

1. All fabricated metal hangers and supports shall be capable of adjustment after installation. Different types of hangers and supports along a pipe length, including bends, shall be kept to a minimum.

2. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.

3. Vertical piping shall be properly supported at each floor and between floors by stays or braces to prevent rattling and vibration.

4. Supports and hangers for plastic and FRP piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.

5. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless steel hangers.

6. Ferrous pipes to be painted shall be painted in accordance with Section 09900S - Painting. Ferrous pipes that require painting or galvanizing shall be supported by galvanized hangers and supports. Stainless steel piping shall be supported by stainless steel saddles and straps (if required).

7. Copper piping shall be supported by plastic coated or copper plated steel hangers and supports.

8. Plastic piping shall be supported by plastic coated steel hangers and supports.

9. Hangers and supports shall provide for thermal expansion throughout the full operating temperature range.

10. Expansion and adhesive type anchors used for pipe hangers and supports shall be Type 304 stainless steel.

C. Metallic hangers and supports may be standard make by Anvil International, Inc., "Witch" by Carpenter & Paterson, Ltd., B-Line Systems, Inc., or equal; and data on the types and sizes to be used shall be furnished to the Engineer for approval. Metallic support system brackets, rods, support clips, clevis hangers, hardware, etc. shall be cast iron or welded steel construction. All gravity type hangers and supports shall be restrained laterally to resist seismic loading and other loading as required by the governing code.

D. Non-metallic support system shall be a heavy duty channel framing system. Channel frames shall be manufactured by the pultrusion process using corrosion grade polyester or vinylester resins. All fiberglass construction shall include suitable ultraviolet inhibitors for UV exposure and shall have a flame spread rating of 25 or less per ASTM E84. Piping accessories, pipe clamps, clevis hangers, support posts, support racks, fasteners, etc., shall be constructed of vinylester or polyurethane resin. Non-metallic support systems shall be standard make Aickinstrut by Aickinstrut, Inc., Unistrut Fiberglass by Unistrut, Inc., Enduro Fiberglass Systems, or equal. The Contractor shall submit data on the types and sizes of approval. Unless otherwise shown or specified the Contractor shall provide support spacings in the conformance with the pipe and support system manufacturer's requirements.

2.03 PROCESS AIR PIPE SUPPORTS

A. Unless specifically designed and detailed on the Drawings, process air piping shall be supported by slide bearings as manufactured by Fluorocarbon Company, Anaheim, California, Anvil International, Inc., Portsmouth, New Hampshire, or equal. Refer to Section 05830S – Bearing Devices and Anchoring for supplemental information and requirements.

B. The slide bearing material shall be 3/32 inch thick, 25 percent glass-fiber reinforced structural grade teflon. The bearing material shall withstand at least 1000 psi (compression) at 250°F with a coefficient of friction between .05 and.08. The performance of bearing and bonding materials shall be unaffected by continual immersion in wastewater containing domestic and industrial waste at a temperature of 210°F.

C. Non-submerged slide bearing type supports shall be provided with a bearing material covering a 120° arc centered at the bottom of the pipe. The Teflon shall be at least 4 inches wide at the underside of the pipe and 8 inches wide at the top of the support. The Teflon material shall be hot press bonded to 10 ga. stainless steel plates for welding to the bottom of the pipe and securing to the top of the support.

D. Submerged slide bearing type supports shall be provided with Teflon bonded to the underside of the hold down strap and the top of the pipe such that the sliding surface is formed between two sheets of Teflon. Each surface shall cover a 120° arc centered at the top of the pipe. On the underside of the strap the Teflon bearing shall be hot press bonded directly to the stainless steel strap or to a 10 ga. stainless steel plate for welding to the strap. At the top of the pipe, the Teflon shall be bonded to a 10 ga. stainless steel plate for welding to the pipe.

E. Pipe straps shall not tightly bind the pipe but shall provide 1/16 inch clearance over the top 180° of the pipe surface.

F. Wall bracket supports shall be used where shown for pipe to be installed adjacent to a wall. Where it is not feasible to install hanger supports, adjustable pipe saddle supports may be used with the permission of the Engineer. Concrete pier supports shall be spaced at a maximum distance of 10 feet and shall be at least 12" wider than O.D. of pipe and 10 inches thick unless otherwise shown on the Drawings. Refer to the Standard Detail Drawings.

G. Small diameter piping (6-inches in diameter or less) shall <u>not</u> be strapped or otherwise secured directly to walls. Suitable wall offset brackets of an approved type shall be used. Anchors shall not be attached using percussion fasteners.

H. Sliding surfaces shall be protected from accumulation of dirt, grit, or other foreign matter.

I. Slide bearings shall be capable of adequately supporting the design loads and shall be attached to pipe and supports as specified and recommended by the manufacturer.

J. The slide bearings shall be installed in the locations shown or indicated on the Drawings, at required elevations, true to orientation and level, assuring that the correct half of each bearing is in its proper position. The Contractor shall store the bearings to protect them from mechanical damage prior to installation, and shall protect the same during and after installation from contamination and damage due to placing of concrete and other materials. The Contractor shall clean the operating surfaces of bearings thoroughly before final assembly.

K. The Contractor shall note that all pipe support locations are not shown on the Drawings and shall follow the Specifications herein in locating supports. Where deviations and modifications are required, they shall be made only with the permission of the Engineer. A detailed layout of pipe supports and hangers shall be submitted for approval.

PART 3 -- EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Support piping connections to equipment by pipe support and not by the equipment.

B. Support large or heavy valves, fittings, flow meters and appurtenances independently of the connected piping.

C. Support no pipe from the pipe above it.

D. Support piping at changes in direction or in elevation, adjacent to flexible joints, expansion joints, and couplings, and where shown.

E. The Contractor shall not install piping supports and hangers in equipment access areas or bridge crane runs.

F. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

G. Install pipe anchors (fixed supports and/or guides) where shown and/or as may otherwise be required to withstand expansion thrust loads and to direct and control thermal expansion. The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that complete details describing location, pipe supports and hydraulic thrust protection are submitted.

- END OF SECTION -

SECTION 15030S

PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor (general contractor awarded the Expansion Project) shall furnish and install all components of the system for identification of piping and equipment as specified hereinafter. The system shall include the application of color coding to all new and altered plant piping. The Contractor shall paint the equipment and piping of all Contracts in the colors herein specified, and in accordance with the requirements of Section 09900S, Painting.

B. In addition to the legends specified herein the Engineer may order the Contractor to furnish and install additional identification legends and arrows at no additional cost to the Owner. Such additional signs may be requested near completion of the work and shall be limited to no more than five (5) signs for each type specified herein. The legends and color combinations for additional signs shall conform to the requirements specified herein.

C. The Contractor shall submit a schedule of the colors and designations proposed in accordance with Section 01302S, Submittals, and this Section. A minimum of four (4) color charts with cross-references to the colors listed herein shall be included with the Submittal.

D. Reference Section 15000S, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 PIPING BAND

A. All new and altered piping shall receive identification bands. Such bands shall be 6-inches wide, neatly made by masking, and spaced at intervals of 30-inches on center regardless of the diameter of the pipe being painted. The Contractor may use approved precut and prefinished metal bands on piping, in lieu of the masked and painted bands, where approved by the Engineer.

2.02 PIPING IDENTIFICATION LEGEND

A. The Contractor shall apply identification legends to all types and sections of piping as shown on the Drawings or as designated by the Engineer. Such legends shall be in the form of plain block lettering giving the name of the pipe content in full or abbreviated form, and showing the direction of flow by arrows. All lettering and arrows shall be of the plastic snap-on type. Seton nameplate "setmarks-", or equal, or they shall be formed by stenciling in an approved manner using white or black as directed and shall have an overall height in inches in accordance with the following table:

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Diameter of Pipe or Pipe Covering	Height of Lettering
3/4 to 1-1/4 inches	1/2-inches
1-1/2 to 2-inches	3/4-inches
2-1/2 to 6-inches	1-1/4-inches
8 to 10-inches	2-1/2-inches
Over 10-inches	3-1/2-inches

B. Identification lettering shall be located midway between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located each fifteen (15) feet in pipe length, and shall be properly inclined to the pipe axis to facilitate easy reading. In the event lettering and arrow identifications are required for piping less than 3/4inch in diameter, the Contractor shall furnish and attach approved color coded-tags where instructed.

C. The colors referenced in the legend are as manufactured by KOP-COAT. They are used for convenience only.

D. Piping and Equipment Identification

Service	Legend	Base	Band
Air, Low Pressure	ALP	No Color	
All valves, pumps, motors, hoist and monorails	-	324 Orange	-
Alum	Alum	Not Painted	
Caustic Solution	Caustic Solution	Alternating Orange and Yellow Tape	
Chlorine Gas	Chlorine Gas	319 Light Yellow	-
Chlorine Solution	Chlorine Solution	339 Medium Yellow	-
Collectors, Slide Gate			
Dewatering Pump Piping	-	300 Aqua Green	-
Digested Sludge	DS	Light Brown/5050V	
Digested Waste Activated	DWAS	Medium Brown	
Digester Gas	DG	No Base	Safety Yellow/2754
Emergency Overflow	EOF	Seagull/5030P	
Filtrate	Filtrate Drain	Grey	
Filtrate Drains	Filtrate Drain	356 Dune Brown	-
Frames and Hose Lines			
Grit Pumping	Grit	300 Aqua Green	315 Tile Red
Heating (HVAC) Piping	HVAC	324 Orange	-
Heating Glycol Return	HGR	Safety Purple/2749	
Heating Glycol Supply	HGS	Safety Purple/2749	

Heating Water Return	HWR	Medium Blue/5173P	
Heating Water Supply	HWS	Medium Blue/5173P	
Hot Service Water	HW3	Kentucky Blue/5205R	
Hydrants	-	Red	
Hydrants	-	319 Light Yellow	-
Natural Gas Piping	Natural Gas	Safety Orange	
Neat Polymer	NP		
Nonpotable Water	NPW	300 Aqua Green	315 Tile Red
Odorous Air	OA		Antique Cream/5054P
Plant Drain	PD	Griffin Gray/5126R	-
Plant Effluent Water	W3	Bright Terrace/5155V	
Polymer Solution	POS	Safety Yellow/2754	Purple Shade/5186T
Potable Water	W1	Medium Blue/5273P	
Primary Sludge	PS	Dark Brown/5067P	306 Light Grey
Process Air	Process Air	Dark Green	
Recirculated Digester Sludge	RDS	Light Brown/5050V	
Return Activated Sludge	Return Act. Sludge	334 Light Brown	303 Dark Blue
Sanitary and Process Drains	Drain	Grey	
Scum Operators, Scum Collectors, Slide Gate Frames and Hose Lines	Scum	305 Olive Green	
Scum Piping	Scum	334 Light Brown	305 Olive Green
Seal Water Piping	Seal Water	Light Green	
Service Air	-	365 Vista Green	-
Sludge			
Spray Piping	-	307 Medium Green	303 Dark Blue
Sump Pump Discharge	SPD	Classic Aqua/5162P	-
Supernatant	Supernatant	Light Brown	
Thickened Waste Sludge	TWAS	Burnt Sienna/5058P	339 Medium Yellow
Waste Activated Sludge	WAS	Dark Brown/5067P	300 Aqua

- END OF SECTION -

SECTION 15095S

VALVES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The requirements of this section shall apply to the general construction contractor for the Expansion Project. This section serves as a reference for components supplied by the Offeror. Loudoun Water will not directly award a purchase order for the goods and associated services for the Expansion Project but will instead assign the Procurement Agreement to the general construction contractor selected for the Expansion Project.

B. The Contractor (general contractor awarded the Expansion Project) shall furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.

C. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated. Except where noted otherwise, valves designated for water service shall conform to pertinent sections of the latest revision of AWWA C500 Specifications. Cast iron valve bodies and parts shall meet the requirements of the latest revision of ASTM Designation A-126, "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B."

D. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.

E. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. The Contractor shall be responsible for coordinating connecting piping. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.

1.02 SUBMITTALS

A. Shop Drawings conforming to the requirements of Section 01302S, Submittals, are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn

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using a ladder-type format in accordance with JIC standards. Shop Drawings for pneumatically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.

B. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall provide the services of a qualified representative of the manufacturer(s) of the equipment named below to check out and certify the installation(s), to supervise the initial operation, and to instruct the Owner's operating personnel in proper operation and maintenance procedures in accordance with the following schedule:

Item	**Valve/Operator Type**	**Minimum On-Site Time Requirements**
1.	Automatic Control Check Valve	One (1) 8-hour day
2.	Surge Anticipators	One (1) 8-hour day
3.	Motor Operated Modulating Valves	One (1) 8-hour day
4.	Motor Operated Open-Close Valves (required only if manufacturer is other than for Item 3 above)	One (1) 8-hour day
5.	Pneumatic Hydraulic Cylinder Operated Valves	One (1) 8-hour day

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies notes.

D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

PART 2 -- PRODUCTS

2.01 FLOW INDICATORS

A. Flow indicators shall be the Akron ball-type as manufactured by Brooks Instrument Co., Fischer and Porter, or equal, and shall have bronze bodies, glass dome, and plastic ball.

2.02 CORPORATION STOPS

A. Corporation stops shall be of bronze with tapered male iron pipe threads on inlets and outlets. Terminal outlets shall have screwed bronze hex head dust plugs or caps. Unions shall be used on all corporation stop outlets with connecting piping. Corporation stops shall have a minimum working pressure rating of 250 psi and shall be as manufactured by Mueller Co., Hays Mfg. Div. of Zurn Industries, or equal.

2.03 FLOOR BOXES

A. Floor boxes shall be provided for all nut operated or floor accessed valves. Floor boxes shall be of the adjustable, sliding type, cast iron, suitable to withstand heavy traffic, as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., or equal. The covers shall be marked with appropriate designations of piping contents (i.e.: water, sewer) and bases shall be the round type. All nut operated valves in this Section shall be clearly identified by stainless steel or laminated plastic identification tags. The tags shall be permanently affixed to the inside of the floor boxes, under grating, etc. and shall bear the embossed letters which clearly identify each valve by its appropriate designation.

B. Two (2) valve operating wrenches shall be supplied in 4 foot lengths with tee handles for each size nut supplied. Valve wrenches shall be Model No. F-2520 as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., Figure No. 122, or equal.

2.04 VALVE BOXES

A. The Contractor shall furnish and install valve boxes as shown on the Drawings and specified herein.

B. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the valve box, sloped outwards.

C. All valve boxes shall be 2-piece cast iron, sliding type, 5-1/4" shaft, with heavy duty traffic weight collar and the lid marked with the appropriate carrier product (i.e.: WATER). Boxes shall be as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., Charlotte Pipe and Foundry Company, or equal.

2.05 STRAINERS

A. Y-Strainers shall be Y-pattern cast iron body, flanged or screwed ends with stainless steel or Monel, 20 mesh strainers. Strainers shall be 200 psi, cold-water service strainers, as manufactured by WATTS, Crane Co., Zurn, or equal.

C. Caustic service Y-strainers shall be provided as shown on the drawings. Strainers shall be full port-full flow design manufactured of 304 or 316 stainless steel body. Y-strainers shall be furnished with flanged ends. The strainer screen shall be 1/32-inch perforation, easily removable, manufactured of the same material as the valve body.

D. Stainless steel Y-strainers shall be provided as shown on the drawings. Strainers shall be full port-full flow design manufactured of 304 or 316 stainless steel body. Y-strainers shall be furnished with flanged ends. The strainer screen shall be 1/32-inch perforation, easily removable, manufactured of the same material as the valve body.

E. PVC and CPVC Y-strainers shall be provided in PVC and CPVC piping and as shown on the Drawings. Strainer shall be provided with PVC or CPVC body and end cap, EPDM or Viton seal as required for the chemical service, and 20 mesh screen. Temperature rating shall be 30°F to 140°F, and pressure rating shall be 150 psi @ 70°F, non-shock. PVC and CPVC y-Strainers shall be as manufactured by Asahi/America, Hayward, or equal.

F. Manually cleaned strainers shall be the duplex basket tapered plug type.

1. Strainers 3-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150 pound standard.

2. Strainers less than 3-inches in diameter shall have screwed end connectors, unless otherwise shown on the Drawings.

3. Strainers shall be constructed with an ASTM A48, Class 30 cast iron body, ductile iron trim, removable 0.045 inch staggered hole perforation, 304 stainless steel filter baskets and gauges on the inlet and outlet.

4. All strainers shall be suitable for 125 psi service.

5. Switching flow from one basket to the other shall be accomplished by moving the handle through a 180° arc. The switching operation shall not stop flow through the strainer and shall provide for on-line removal of either basket with the other basket functional. The plug shall be automatically positioned with integral stops and shall be easily lifted and reseated under pressure.

6. The strainer shall be designed to minimize the possibility of material bypassing the plug while being rotated and to prevent debris from building up under the plug. The strainer covers shall be designed for quick opening with swing away yoke.

7. Each basket compartment shall have a side drain outlet.

8. All strainers shall be provided with support legs.

9. Duplex basket strainers shall be similar to the Model 53BTX as manufactured by Hayward, or equal.

G. PVC and CPVC simplex basket strainers shall be provided in PVC and CPVC piping as shown on the Drawings. 1/2”-4” strainers shall be one-piece molded body with (3) ports to facilitate straight-thru flow pattern or u-shape flow pattern as required. Connections shall be true union type to ease installation/future maintenance. The cover, vent plug, and drain plug shall all be hand-removable, requiring no tools. EPDM or Viton seals shall be used as required for chemical service, and internal baskets shall be 1/32” perforation (20-mesh) for 1/2”-1” sizes, and 1/8” perforation for 1-1/2”-8” sizes. 6” and 8” strainers shall be fabricated construction and shall contain flanged connections as standard. The pressure rating for 1/2”-8” sizes shall be 150 psi @ 70°F, non-shock. Strainers shall be manufactured by Hayward Industrial Products, or equal.

A. Quick disconnect type coupling for compressed/service air shall be provided where indicated on the Drawings. Coupling shall provide for instantaneous shutoff in socket end when lines are disconnected. Couplings shall be constructed of 316 stainless steel with a BUNA-N O-ring and integral safety lock. Couplings shall comply with Military Specification 4109 (interchangeable with standard plug of the same size).

2.07 BACKFLOW PREVENTERS

A. Backflow preventer shall be the size shown on the Drawings and shall be of the double check valve principle. Backflow preventer installation shall include isolation valves and four test cocks, furnished as an assembly. For backflow preventers less than 2-1/2", the installation assembly also shall include a strainer. Isolation valves for backflow preventers shall be ball valves, except for size 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The backflow preventer shall be a WATTS 709, or equal.

B. Reduced Pressure Backflow Preventer shall be of the size shown on the Drawings, and shall be of the reduced pressure principle type in accordance with AWWA Standards C510 and C511, with two (2) independent operating spring loaded check valves and one (1) spring loaded, diaphragm actuated, differential pressure relief valve shall be installed between the check valves. Backflow preventer shall be bronze body construction, with EPT rubber discs and Buna-N and nylon diaphragm. Screws and springs shall be of stainless steel. End connections shall be screwed, unless otherwise specified or shown on the Drawings. Reduced pressure backflow preventer installations shall include isolation valves and four test cocks, furnished as an assembly. For reduced pressure backflow preventers less than 2-1/2" the installation assembly also shall include a strainer. Isolation valves for reduced pressure backflow preventers shall be ball valves, except for sizes 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The reduced pressure backflow preventer shall be as manufactured by Beeco Division, Hersey Products Inc., Aergap Model 6CM, WATTS 909, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Except where noted otherwise herein, all valves shall be installing and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes, and shall bear no stresses due to loads from the adjacent pipe. The Contractor shall be responsible for coordinating connecting piping.

B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated and cylinder operated valves shall be tested for control operation as directed by the Engineer.

C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.

D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Engineer. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.

E. Valve boxes shall be set plumb, and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

3.02 SHOP AND FIELD TESTING

A. Shop and field testing of valves shall be as follows:

1. Certified factory testing shall be provided for all components of the valve and operator system. Valves and operators shall be shop tested in accordance with the requirements in the latest revision of AWWA C500, including performance tests, leakage test, hydrostatic tests, and proof-of-design tests. The manufacturer through the Contractor shall submit certified copies of the reports covering the test for acceptance by the Engineer.

2. Shop testing shall be provided for the operators consisting of a complete functional check of each unit. Any deficiencies found in shop testing shall be corrected prior to shipment. The system supplier through the Contractor shall submit written certification that shop tests for the electrical/pneumatic system and all controls were successfully conducted and that these components provide the functions specified and required for proper operation of the valve operator system.

3. The Contractor shall conduct field tests to check and adjust system components, and to test and adjust operation of the overall system. Preliminary field tests shall be conducted prior to start-up with final field tests conducted during start-up. The factory service representative shall assist the Contractor during all field testing and prepare a written report describing test methods, and changes made during the testing, and summarizing test results. The service representative shall certify proper operation of the valve operator system upon successful completion of the final acceptance field testing.

4. Preliminary and final field tests shall be conducted at a time approved by the Engineer. The Engineer shall witness all field testing.

5. All costs in connection with field testing of equipment such as energy, light, lubricants, water, instruments, labor, equipment, temporary facilities for test purposes, etc. shall be borne by the Contractor. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur

to equipment prior to the time when the Owner formally takes over the operation thereof.

6. Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components. Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly. The preliminary field test report must be approved by the Engineer prior to conducting final field acceptance tests. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation specified or otherwise directed by the Engineer.

7. Final field acceptance tests shall be conducted simultaneously with the start-up and field testing of the pumps, air compressors, process air blowers, etc. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing. Performance of pneumatic valves and compressed air system under normal operating conditions and during simulated power failures shall be checked.

8. Field testing shall include optimization of opening and closing times of the valves. The Contractor shall provide the means for accurate measurement of pipeline pressures as directed by the Engineer. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

- END OF SECTION -

SECTION 15100S

VALVE OPERATORS AND ELECTRIC VALVE ACTUATORS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Equipment shall be provided in accordance with the requirements of Section 11000S – Equipment General Provisions and Section 15000S – Basic Mechanical Requirements.

B. Reference Section 15390 – Schedules, which shall be included in the Specifications or indicated in the Drawings provided as part of the Expansion Project, for additional information on valves and operators/actuators.

C. The electric valve actuators shall meet the signal requirements described by the Offeror in the supplied PIDs and control strategies.

D. Valve operators and electric valve actuators shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valves will be subjected.

E. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Engineer. There shall be no mounting restrictions on the electric valve actuator.

F. The valve operators and electric actuators shall be the full and undivided responsibility of the valve manufacturer in order to ensure complete coordination of the components and to provide unit responsibility.

1.02 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01302S, Submittals; and Section 11000S, Equipment General Provisions.

B. Certification that the force required to operate all valves is as specified herein.

1.03 WARRANTY AND GUARANTEE

A. The warranty period shall be for two (2) years.

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PART 2 -- PRODUCTS

2.01 GENERAL

A. Electric actuators shall be provided where specified in the Valve Schedule in Section 15390 – Schedules.

B. Manual operators shall be provided on all valves which do not receive electric actuators. Manual operator type shall be as specified herein and as shown on the Drawings.

C. Quarter turn valves 8” and greater in size shall have geared operators. Gate valves 14” and greater in size shall have geared operators.

D. Operators/actuators shall be furnished with conservatively sized extension bonnets, extension stems, or torque tubes, and all required appurtenances required for a complete installation. Operators furnished with extension bonnets shall include stainless steel extension stems, or stainless steel torque tubes.

2.02 MANUAL OPERATORS

A. Unless otherwise specified or shown on the Drawings, manual operator type shall be as follows:

1. Buried valves shall be equipped with nut operators, extended stems, and valve boxes. Where the depth of the operating nut is more than 4 feet below finish grade, a valve operator extension shall be provided to bring the operating nut to within 18-24 inches of the surface.

2. Exposed valves up to 6-inch shall be lever operated (except gate valves).

3. Exposed valves 8-inches and larger shall be handwheel operated.

4. Exposed gate valves shall be handwheel operated.

5. Valves with centerline of operator located more than 6-feet above the floor or platform from which it is to be operated shall have a chainwheel operator unless otherwise indicated on the Drawings.

B. Manual operators shall be rigidly attached to the valve body unless otherwise specified or shown on the Drawings.

C. All operators shall turn counter-clockwise to open and shall have the open direction clearly and permanently marked.

D. Valve operators shall be designed so that the force required to operate the handwheel, lever, or chain (including breakaway torque requirements) does not exceed 80 pounds applied at the extremity of handwheel or chainwheel operator. Design pressures for sizing of valve operators shall be the piping test pressure for the piping in which the valve is to be installed as shown in the Piping Schedule in Section 15390 – Schedules.

E. Handwheels for valves operators shall not be less than 12 inches in diameter. The maximum diameter of any handwheel shall not exceed 24”.

F. Nut operators shall have standard 2-inch square AWWA operating nuts designed in accordance with AWWA C504-94.

G. Geared manual operators shall be of the worm gear, traveling nut or scotch yolk type except manual operators for butterfly valves 18-inch in diameter or larger which shall be worm gear, unless otherwise indicated in the individual valve specification. Gear operators shall be of the worm gear or bevel gear type. Gear box designs incorporating end of travel stops in the housing shall be equipped with AWWA input stops. Each gearbox shall require a minimum of 10 turns for 90 degree rotation or full valve stem travel and shall be equipped with a mechanical valve position indicator.

H. Manual operators on below grade (and vault installed) valves shall be permanently lubricated and watertight under an external water pressure of 10 psi.

2.03 ELECTRIC VALVE ACTUATORS

A. Electric Actuators shall be open/close service or modulating service as specified in the Valve Schedule in Section 15390 – Schedules.

1. Open/Close (non-modulating) valve actuators shall be IQ series as manufactured by Rotork, SA series as manufactured by AUMA, or Series 2000 as manufactured by EIM Controls.

2. Modulating valve actuators shall be Type IQM as manufactured by Rotork, Type SAR as manufactured by AUMA, or Series 2000 Futronic as manufactured by EIM Controls.

B. Performance Requirements

1. The actuators shall be designed for indoor and outdoor service and shall be capable of mounting in any position.

2. Torque capacity of the actuators shall be sufficient to operate the valves with the maximum pressure differential, as indicated in the Valve Schedule in Section 15390, with a safety factor of 1.5. Actuators in modulating service will be selected such that the required dynamic valve torque is no more than 60% of the electric actuator’s maximum rated breakaway of torque.

3. Operating time for full limits of travel shall be not more than 2 seconds per inch diameter of the valve, +/- 50 percent through 20 inches; +/- 30 percent for valves 24 inches and larger. Operating time shall not be less than 60 seconds for all modulating valves.

4. Actuators shall be capable of operating in ambient temperatures ranging from 0 degrees F – 160 degrees F.

5. For open/close (non-modulating) actuators, the gearing, motor and contactor shall be capable of 60 starts per hour without overheating.

6. For modulating actuators, the gearing, motor and contactor shall be capable of 1200 starts per hour without overheating.

C. The actuators shall include, in one integral housing, individual compartments for the motor, gearing, wiring terminals, and control circuits. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The inner seal shall protect the motor and all other internal electrical elements of the actuator from entrance of moisture and dust when the terminal cover is removed. Double cartridge shaft seals shall be provided on the hand wheel and output shafts for weatherproof protection. All external fasteners shall be stainless steel. Compartments shall be provided with moisture and dustproof rigid cast covers meeting NEMA 6, certified to submergence in 6 ft of water for 30 minutes. Actuators located in classified areas shall be suitable for use in Class 1, Division 1, Group D environments.

D. All gearing shall be hardened alloy steel or bronze and shall be rated at twice the output torque of the operator and shall be designed to withstand the stall torque of the motor without failure. Output drive gearing shall consist of a worm shaft and worm gear pinion operating in an oil bath. The worm gear pinion shall be alloy bronze. Worm gear drive shall be self-locking to prevent creeping of the valve disc in an intermediate position. Heavy duty grease shall protect gearing and sealed ball bearings of the main shaft for five years without changing. Motor reduction gearing shall be spur or planetary gearing and shall allow for field repair and change in gear ratio. For quarter turn applications, overtravel of the operator shall be prevented by internal mechanical stops cast into the actuator.

E. A mechanical dial position indicator shall be furnished to continuously indicate the position of the valve at and between the fully open and fully closed positions. The indicator shall be driven by gearing driven off of the main worm gear pinion and shall operate when the actuator is in either the electrical mode or manual mode.

F. A handwheel shall be permanently attached for manual operation. A gear assembly shall be provided between the handwheel and the worm shaft if required to reduce the force necessary to operate the handwheel to less than 40 pounds. A positive declutch mechanism shall engage the handwheel when required. When the actuator is set in the declutched position for handwheel operation, it shall return automatically to electric operation when actuator motor is energized. The handwheel shall not rotate during electric operation nor shall a fused motor prevent handwheel operation.

G. The drive motor shall be specifically designed for actuator service and shall be characterized by high starting torque and low inertia. Motors shall be 460 volts, three phase, 60 Hz AC reversible squirrel cage induction type motors and shall be specifically designed for modulating service where indicated on the Valve Schedule in Section 15390. Motors shall be totally enclosed, nonventilated, with NEMA Class F insulation minimum (Class H for modulating actuators) and a maximum continuous temperature rating of 120 degree C (rise plus ambient). A 120 VAC space heater shall be provided in the motor compartment. The electric motor shall have a time rating of at least 15 minutes at 104°F

(40°C) or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque. Motor bearings shall be permanently lubricated by premium lubricant. The motor shall have plug and socket electrical connection to facilitate easy removal and replacement. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator. The motor shall include single phase protection. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits, connected to a tripping device. Fast acting fuses shall be provided to protect solid state components. The motor shall be capable of starting against the rated load in either the open or close direction when voltage to the motor terminals is plus or minus ten (10) percent of nameplate rating.

1. Open/Close actuators shall be furnished with electro-mechanical reversing starters.

2. Modulating actuators shall be furnished with solid state reversing starters utilizing thyristors.

H. Leads from the motor shall be brought to the control circuit (limit switch) compartment without external piping or conduit box. An adequately sized space heater shall be installed in the control circuit compartment to aid in the prevention of damage resulting in from condensation. The following items shall be located in the control circuit compartment.

1. Torque limit switches shall be provided to de-energize the motor control circuit in the event of a stall when attempting to unseat a jammed valve and when torque is exceeded during valve travel. Each actuator shall have an open direction torque switch and a close direction torque switch. The torque switches shall be mechanically operated and able to be set in torque units. Torque switches shall be calibrated prior to the actuator's assembly to the valve.

2. Travel limit switches shall be provided to de-energize the motor control circuit when the actuator reaches the limits of travel in the open and close directions. The limit switch drive shall be of the counter gear type and "in step'" with the actuator output drive at all times in either the electrical or manual mode of operation. A minimum of six (6) contacts, three (3) normally open and three (3) normally closed, shall be supplied at each end of valve travel. Four (4) additional contacts shall be provided to report end of travel or any desired position between ends of travel.

I. Modulating actuators shall have a position feedback potentiometer mounted directly to the valve actuator gearing inside the gearing compartment. The potentiometer shall provide a 4-20 mA signal corresponding to valve position. Modulating valve actuators shall be designed to respond to either a 4-20mADC analog signal or a digital pulse signal as specified herein or as required to coordinate with the requirements of Division 17S.

1. Modulating valve actuators designed to respond to a 4-20mADC signal shall be provided with a valve positioner which shall position the valve proportional to an externally generated 4-20mADC signal. The valve positioning control circuitry shall position the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field

adjustable to fail to the “open,” “closed,” or “last” position on loss of 4-20 mADC command signal.

2. Modulating valve actuators designed to respond to “pulse” open/close signals shall operate the valve during the time the open or close pulse signal is high. Modulating actuators designed to respond to “pulse” open/close signals shall have the latching circuitry described above for open/close actuators disabled.

J. The electrical terminals shall be housed in a double sealed terminal compartment isolated from the rest of the actuator components. The actuators shall be designed to operate from a single 480VAC, 3-phase source. The actuators shall be furnished with fuses inside of the terminal compartment. A quantity of two – ¾ inch NPT conduit entries shall be furnished.

K. Actuators shall contain wiring and terminals for the following control functions. All dry contacts shall be rated for 5A at 250VAC.

1. Open, Close, and Stop commands from external dry contacts (utilizing internal 24VDC [120VAC] power supply) and/or from an external signal of 12V to 120V. The inputs for the open, close, stop signals shall be field selectable to be respond to either maintained or momentary remote signals. In momentary mode, the actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact signal unless a stop signal is received.

2. Emergency override input from a normally closed or normally open contact. The actuator shall either open or close (field selectable) upon receiving the emergency override input.

3. Remote Local-Off-Remote selector switch, Open/Close pushbuttons, and Open/Closed pilot lights for a remote manual control station (see below). The remote Local-Off-Remote selector switch and Open/Close pushbuttons shall be a dry contact input to the actuator control circuitry. The Open/Closed pilot lights shall be powered from the valve actuator control power.

4. Four (4) unpowered contacts shall be provided which can be selected to indicate valve “Opened” and “Closed” position, “Remote” status of the actuator, and fail status of the actuator. The fail status contacts shall activate upon motor overtemperature and actuator overtorque as a minimum.

5. Terminals for 4-20mADC position command and 4-20mADC position feedback as described above for modulating actuators.

L. Local Controls

1. Actuators shall be furnished with a Local-Off-Remote selector switch; Open, Close, and Stop pushbuttons for local control; a red lamp indicating closed and a green lamp indicating open. L-O-R switch shall be padlockable in any of the three positions.

a. When the LOR is in the “Local” position, open/close control shall be by the open and close pushbuttons on the actuator. The stop push button shall stop the actuator travel.

b. When the LOR is in the “Off” position, the actuator shall not operate.

c. When the LOR is in the “Remote” position, the actuator shall be controlled by remote inputs from the PLC or from the remote manual controls station.

2. The local controls shall be arranged so that the direction of travel can be reversed without the necessity of stopping the actuator.

M. Remote Manual Control Station

1. Where indicated in the Valve Schedule in Section 15390 – Schedules, manual actuator controls shall be furnished in a separate NEMA 4X stainless steel enclosure (NEMA 7 if located in a classified area). Manual control station controls shall include Hand–Off-Auto Selector switch; Open, Stop, and Close pushbuttons; a red lamp indicating closed and a green lamp indicating open.

a. When the HOA is in the “Hand” position, open/close control shall be by the open and close pushbuttons on the remote manual control station. The stop push button shall stop actuator travel.

b. When the HOA is in the “Off” position, the actuator shall not operate.

c. When the HOA is in the “Auto” position, the actuator shall be controlled by remote inputs to the valve actuator from the PLC.

PART 3 -- EXECUTION

3.01 MANUFACTURER’S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000S and shall include the following site visits for electric actuators:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	2	2
Services after Startup	1	1

3.02 INSTALLATION

A. All valve actuators shall be installed in accordance with the manufacturer's published recommendations and the applicable specification sections for valves, and motor controls.

B. Valve actuators shall be factory coated in accordance with the manufacturer's standard paint system.

3.03 SHOP TESTING

A. Shop testing shall be in accordance with Section 11000S and with the following additional requirements:

1. Conduct a complete functional check of each unit. Correct any deficiencies found in shop testing prior to shipment.

2. Submit written certification that:

   a. Shop tests for the electrical system and all controls were successfully conducted;

   b. Electrical system and all controls provide the functions specified and required for proper operation of the valve operator system.

3. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment shall simulate each typical valve load and the following parameters should be recorded:

   a. Current at maximum torque setting

   b. Torque at maximum torque setting

   c. Flash Test Voltage

   d. Actuator Output Speed or Operating Time

   e. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

   f. Verification of actuator torque rating with valve.

3.04 FIELD TESTS

A. Field testing shall be in accordance with Section 11000S and with the following additional requirements:

1. Valve actuators shall be field-tested together with the associated valves.

2. Test all valves at the operating pressures at which the particular line will be used.

3. Test all valves for control operation as directed.

4. Field testing shall include optimization of opening and closing times of the valves.

Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

B. Preliminary Field Tests

1. General: Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components.

2. Scope: Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly.

3. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation, as specified or otherwise directed.

C. Final Field Tests

1. Final field tests shall be conducted in accordance with the latest revision of AWWA C500.

2. Final field tests shall be conducted simultaneously with the start-up and field testing of the pumps.

3. Final field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing.

- END OF SECTION -

SECTION 15101S

BUTTERFLY VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000S, Basic Mechanical Requirements.

B. Reference Section 15390 – Schedules, which shall be included in the Specifications as part of the Expansion Project, for additional information on valves and operators/actuators.

PART 2 -- PRODUCTS

2.02 BUTTERFLY VALVES (PROCESS AIR)

A. Isolation valves for low pressure (less than 25 psig) air service shall be high performance butterfly valves to ensure air-tight shut-off when closed. All valve components shall be suitable for continuous operation at temperatures up to 300°F with a 25 psig minimum working pressure. Materials of construction shall be as follows:

1. Valve bodies - 316 stainless steel
2. Valve discs and shafts – 316 stainless steel
3. Valve seals – Viton, silicone or PTFE

B. Modulating (throttling) valves for low pressure (less than 25 psig) air service where air-tight shut-off is not required shall be resilient-seated butterfly valves, conforming to AWWA C504. Valves shall be as manufactured by Pratt, Mueller Co., DeZurik, or engineer approved equal. All valve components shall be suitable for continuous operation at temperatures up to 300°F with a 25 psig minimum working pressure. Materials of construction shall be as specified below. Valves shall otherwise be as described above under Butterfly Valves (Water Service).

1. Valve bodies - 316 stainless steel
2. Valve discs and shafts – 316 stainless steel
3. Valve seals – Viton, silicone or PTFE

C. Alternatively, high performance butterfly valves as specified above may be provided for modulating service. High performance butterfly valves shall be provided for modulating service where called for on the drawings or specified herein.

E. Valves less than 30-inches shall have a flanged, wafer or lug style body and be compatible with ASME B16.1 flanges. Valves 30-inches or larger shall have flanged end connections conforming to ANSI B16.1, 125 pound rating.

D. Manually operated isolation valves shall be provided with a handwheel or chainwheel, as required and/or as shown on the drawings, operator and shall provide for tight shut-off. A mechanical dial indicator shall be provided on the operator to continuously indicate valve positions. Where specified and/or as shown on the drawings, the Contractor shall provide motor actuators meeting the requirements of Specification Section 15100S. Motor actuators for throttling valves shall provide for modulating operation. Cycle time from full open to full closed shall be approximately 60 seconds. 4-20 ma position feedback signals shall be provided for each actuator. Contractor shall wire 4-20 ma position signals to the PLC.

- END OF SECTION -

SECTION 15109S

PLUG VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000S, Basic Mechanical Requirements.

B. Reference Section 15390 – Schedules, which shall be included in the Specifications provided as part of the Expansion Project, for additional information on valves and operators/actuators.

PART 2 -- PRODUCTS

2.01 PLUG VALVES

A. Plug valves shall be of the non-lubricated, eccentric seating plug type with synthetic rubber-faced plugs as manufactured by DeZurik Company, Pratt, Milliken, or equal. All valves shall be provided with limit stops and rotate 90° from fully open to fully shut. The minimum working pressure for all valves shall be 150 psi, and the test pressure shall be at least 270 psi for valves up through 12-inch and at least 230 psi for valves 14-inch and larger. The port area of valves shall be at least 80 percent of full pipe area for valves less than 24-inches and 70 percent for valves 24-inches and larger, unless otherwise specified herein or indicated in the appropriate Valve Schedule in Section 15390, Schedules. The body materials shall be of epoxy coated cast iron or semi-steel, unless specified otherwise. Seats shall have a welded overlay of 90 percent pure nickel and machined to a finish containing no stress cracks. Plug facings shall be of Hycar, or equal and completely suitable for use with domestic sewage.

B. The shaft seal shall be either the bronze cartridge type with at least two O-Rings, monolithic V-Type, U-Cup Type, or pull down packing type. If monolithic V-Type, U-Cup Type, or pull down packings are utilized, it shall be self-adjusting, self-compensating type. Packing shall be as manufactured by Chevron, or equal. Plug valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator.

C. All buried valves shall have mechanical joint ends (unless otherwise shown), conforming to ANSI A21.11 (AWWA C 111), and shall be operated with a standard AWWA 2-inch square nut through a totally enclosed worm gear actuator. Valve boxes shall be installed with all buried plug valves and shall be as specified herein.

D. Unless otherwise shown, all exposed valves 4-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150 pound standard with face-to-face dimensions of standard plug valves. Valves smaller than 4-inches in diameter shall have screwed ends, unless otherwise noted.

E. Valves 8-inches in diameter and larger shall be handwheel or floorstand operated where required or indicated on the Drawings through totally enclosed worm gear actuators, unless otherwise specified or shown on the Drawings. Valves 6-inches in diameter and smaller shall have lever operators, unless otherwise specified or noted on the Drawings. Manual operators for plug valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators.

F. The manufacturer shall certify that the plug valves are capable of operating in continuous duty service under these pressures and flow conditions.

G. Each valve shall by hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

H. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

- END OF SECTION -

SECTION 15170S

LOW VOLTAGE ELECTRIC MOTORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The requirements of this section shall apply to the general construction contractor for the Expansion Project. This section serves as a reference for components supplied by the Offeror. Loudoun Water will not directly award a purchase order for the goods and associated services for the Expansion Project but will instead assign the Procurement Agreement to the general construction contractor selected for the Expansion Project.

B. The Contractor (general contractor awarded the Expansion Project) shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all low voltage electric motors as shown on the Drawings and specified herein. All motors required for this Contract shall comply with this Section unless otherwise noted.

1.02 CODES AND STANDARDS

A. Motors and related accessories shall be designed, manufactured, and/or listed to the following standards as applicable:

1. Institute of Electrical and Electronics Engineers (IEEE)

    a. IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators

2. National Electrical Manufacturer's Association (NEMA)

    a. NEMA MG 1 – Motors and Generators

3. Underwriters Laboratories (UL)

    a. UL 547 – Standard for Safety Thermal Protectors for Motors
    b. UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations
    c. UL 1004-1 – Standard for Rotating Electrical Machines
    d. UL 1004-3 – Standard for Thermally Protected Motors
    e. UL 1004-8 – Standard for Inverter Duty Motors

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01302S, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts List.

B. Each submittal shall be identified by the applicable specification section.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Individual shop drawings for electric motors shall be submitted in accordance with the procedures and requirements set forth in the General Conditions and Section 01302S, Submittals, unless submitted as a part of the shop drawings for the driven equipment.

D. Shop drawings for electric motors shall include motor data sheets, dimensioned drawings, wiring diagrams for devices such as space heaters, temperature devices, and shaft grounding rings. Shop drawings shall identify electric characteristics and design, mechanical construction, manufacturer's name, type and pertinent specifications for the use intended, along with the name of the equipment to be driven. For motors rated 50 horsepower or greater, submittal of motor data for acceptance shall include, as a minimum, the following:

1. Manufacturer's type and frame designation
2. Horsepower rating
3. Time rating (per NEMA Standards)
4. Ambient temperature rating
5. Motor winding insulation system designation
6. RPM at rated load
7. Frequency
8. Number of phases
9. Rated-load amperes
10. Voltage
11. Code letter (starting KVA per horsepower)
12. Design letter for integral horsepower induction motors (per NEMA Standards)
13. Service factor
14. Temperature rise at full load and at service factor load
15. Efficiency at 1/4, 1/2, 3/4 and full load

16. Power factor at 1/4, 1/2, 3/4 and full load

17. Motor outline, dimensions and weight

18. Motor winding insulation system description

19. Horsepower required by connected machine at specified conditions (load curves) shall be supplied for all compressors, propeller and positive displacement pumps.

The foregoing data shall also be verified after manufacture and shall be included with the information to be furnished in the operation and maintenance manuals specified.

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Electric motors shall be manufactured by Baldor/Reliance Electric Company; Nidec Motors; Toshiba Industrial and Power Systems, Inc.; Siemens Energy & Automation, Inc.; General Electric Company; or equal.

2.02 MATERIALS AND CONSTRUCTION

A. Motors shall be built in accordance with the latest standards of NEMA, including, but not limited to MG-1 and MG-2, IEEE, ANSI and to the requirements specified herein.

B. Type

1. Unless otherwise noted, motors specified herein shall be polyphase squirrel cage, NEMA Design B, or single phase capacitor or repulsion start induction motors. Special equipment requiring a motor drive with unusual characteristics shall be equipped with a definite purpose motor to meet the necessary requirements.

2. Unless otherwise shown or specified, all motors 1/2 horsepower or larger shall be three- phase, 60 Hertz, NEMA Design B, squirrel cage induction motors designed for operation at 480 volts or greater as specified herein or shown on the Drawings.

3. Unless otherwise specified in the individual equipment specification for the driven equipment, or as required by the dynamic characteristics of the load as determined by the manufacturer of the machine to be driven, all polyphase squirrel cage motors shall be designed to withstand the starting voltage shown on the Drawings and shall have torque and locked rotor current characteristics as specified for NEMA Design B motors.

4. All motors 2 horsepower and smaller shall have windings encapsulated with a flexible epoxy compound, or insulated with a flexible epoxy compound, or insulated with the manufacturer's premium quality system which shall be subject to acceptance by the Engineer.

5. All motors above 250 horsepower shall have stator windings vacuum impregnated with a polyester insulation compound.

6. Unless otherwise noted, all motors smaller than 1/2 horsepower shall be standard single-phase capacitor start or repulsion start induction type designed for operation on 120 volts or 208 volts, 60 Hz alternating current. The motor shall deliver rated load without exceeding an 80 degrees C temperature rise while operating in a 40 degrees C ambient temperature. Small fan motors less than 1/4 HP may be split-phase or shaded pole type. Shaded pole motors rated more than 1/4 horsepower are not acceptable. Fractional horsepower motors shall be completely equipped with all necessary auxiliary components for starting and labeled as "Thermally Protected". Insulation shall be Class B, except that submersible motors shall have epoxy encapsulation. Unless otherwise noted, the motors shall be totally enclosed. Small fan motors may be of the open type where they are suitably protected from moisture dripping and lint accumulation. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

7. Where specified, vertical hollowshaft motors shall be designed to carry the motors', pumps', and associated equipment's full thrust. The motors shall be equipped with grease lubricated spherical roller thrust bearings and lower radial guide bearings. Vertical hollowshaft motors shall be fitted with nonreversing ratchet assemblies where required by equipment specifications. Vertical adjustment shall be provided by means of a lockable nut at the top of the shaft.

8. Vertical hollowshaft motors shall have adequate thrust bearings to carry all motor loads and any other operating equipment loads. Horizontal motors shall not be installed where subjected to external thrust loads.

C. Rating

1. Each motor shall develop ample torque for its required service through its acceleration range and throughout its rated load range. The rating of the motors offered shall in no case be less than the horsepower shown on the Drawings or elsewhere specified. It should be noted that the motor sizes indicated on the Drawings or as otherwise specified herein, are motor sizes required to operate the specific equipment which is specified. Higher rated motor sizes may be

determined from the actual equipment submitted, approved, purchased, and installed. Protective devices, motor starters, disconnect switches, and other necessary equipment shall be furnished and installed for the actual motor sizes required at no additional cost.

2. Motor ratings shall be based on continuous operation. The maximum temperature rise for open and drip proof type motors shall not exceed 90 degrees C, and for totally enclosed type motors shall not exceed 80 degrees C.

D. Motor Winding Insulation

1. Insulation shall be as specified for each particular type or class of motor. The insulation system shall provide a high dielectric strength, long life covering for the windings which may be required to operate in a continually damp, corrosive, and/or chemically contaminated environment. The insulation shall be resistant to attack by moisture, acids, alkalies, abrasives, and mechanical and thermal shock. Leads shall be sealed with a non-wicking, non-hydroscopic insulation material.

2. Motor insulation resistance may be checked at any time after delivery to the job site or during the warranty period. Encapsulated motor stators may be subjected to insulation testing while completely submerged in water. Any motor not meeting the requirements specified herein will be rejected and shall be promptly replaced at no cost to the Owner.

3. Torque and locked rotor current characteristics for three phase motors shall be NEMA Design B. The locked rotor KVA/HP input at full voltage for 10 horsepower. motors and larger shall not exceed that permitted for Code Letter "J", except for specialized equipment requiring a motor drive with special definite characteristics.

4. Unless otherwise specified, non-inverter duty motors shall be furnished with a Class F insulation system. Unless otherwise specified, inverter duty motors shall be furnished with a Class H insulation system. In either case, temperature rise shall be limited to that for Class B insulation. Output torque and speed characteristics of each motor shall be suitable to operate the driven equipment through the full range of acceleration and operating load conditions without exceeding the nameplate current rating, and/or temperature rise.

E. Nameplates

1. The motor manufacturer's nameplate shall be engraved, embossed, or stamped on a stainless steel sheet and fastened to the motor frame with No. 4 or larger oval head stainless steel screws or drive pins. Printed or laser-etched nameplates are not acceptable.

2. Nameplates shall include as a minimum, Items 1 through 19 as listed in Paragraph 1.04D of this Section in addition to that required by NEMA standards. The nameplate shall be positioned so as to be readily visible for inspection as installed in the facility.

F. Design

1. Motors shall be designed to accelerate and drive the connected equipment under all normal operating conditions without exceeding nameplate ratings.

2. Motors specified for operation with variable frequency drives shall be inverter duty rated. Motors shall be considered inverter duty rated only if they meet all of the requirements for NEMA MG-1 Part 31.

3. Motors shall be designed to output 100 percent of nameplate horsepower under continuous duty service without exceeding the temperature rise specified herein when controlled by the actual drives furnished. Inverter duty motors shall be designed to operate down to 10% of full load speed without the need for a line powered cooling fan.

4. Unless otherwise specified, electric motors shall be furnished with service factors in accordance with NEMA MG-1 as follows:

Type of Motor	**Service Factor**
Non-inverter Duty	1.15
Inverter Duty	1.0

5. Design selection with respect to the driven machine shall be such that the requirements do not exceed 85 percent of the motors' maximum rating modified by service factor, ambient temperature, enclosure, altitude and electrical service. The electrical service conditions shall be assumed to be 10 percent undervoltage, 5 percent underfrequency, and 3 percent voltage unbalance. Altitude shall be assumed to be the project site elevation plus 10 percent. Ambient temperature shall be assumed to be 95 degrees F in exterior locations, 104 degrees F (40 degrees C) in interior locations, and 122 degrees F (50 degrees C) within housings or enclosures; except where higher temperatures may be encountered within or on individual items of equipment. The applicable paragraphs of NEMA MG-1 shall be used in making the design selection.

6. Motors used with belt drives shall have sliding bases to provide for belt take up.

7. Terminal boxes shall be of sufficient size to accommodate the required quantity and size of conduits. Gasketed terminal boxes shall be furnished with all splash-proof and totally enclosed motors. NEMA ratings of the terminal boxes shall be suited for the application. Motors located in hazardous locations shall be furnished with terminal boxes suitable for the specific Class, Division, and Group suitable for the application. Terminal boxes shall be sized to accommodate accessory equipment such as motor differential current transformers, where required.

8. Terminal boxes for horizontal motors shall be located on the left-hand side when viewing the motor from the drive shaft end and shall be so designed that conduit entrance can be made from above, below, or either side of the terminal box.

9. Motors larger than 250hp shall be manufactured with the six stator coil leads wired to a suitably sized motor junction box for application in a differential relay scheme. Current transformers shall be provided by the motor manufacturer and installed in the factory. All ground connections and current transformer connections shall be made in the factory.

G. Construction

1. Frames, mounting means, and shafts shall meet NEMA Standards for the horsepower, RPM, and enclosure selected. Enclosures shall be selected according to the degree of mechanical protection required and shall not be of aluminum construction. All motors shall have an manufacturer's standard shop machinery finish, consisting of a rust-resisting priming coat of zinc chromate and a finish coat of alkyd machinery enamel. Reference Section 09900S, Painting.

2. Motors shall have cast iron frames and a heavy gauge steel terminal box, with neoprene gaskets between the frame and the box and between the box and its cover. A grounding lug(s) shall be provided inside the terminal box.

3. Motors weighing more than 50 pounds shall be equipped with at least one lifting eye. All lifting hardware shall be corrosion resistant.

4. Motors located in hazardous locations shall be totally enclosed and suitable for the specific Class, Division, and Group suitable for the application.

5. Motors located in Class I or II, Division 1 hazardous locations shall bear a U.L.-674 label and shall be provided with a breather/drain approved for the hazardous location. The U.L. listed breather/drain shall prevent the entrance of contaminants while allowing moisture to drain out of the motor.

6. When located outdoors, or elsewhere if specified, motors shall be totally enclosed, non-ventilated (TENV) or totally enclosed, fan-cooled (TEFC) machines, unless otherwise noted. Totally enclosed motors shall be provided with two (2) 1/4 inch drain holes drilled through the bottom of the frame, which allows complete drainage of the frame. Where specified, TEFC motors controlled by a variable frequency drive shall be provided with a separately powered cooling fan motor that runs at 60HZ to ensure proper cooling of the motor at low speeds. Cooling fan motor shall be suitable for 120VAC, single phase operation. Vertically oriented motors located outdoors shall be provided with a drip cover over the fan end to prevent accumulation of precipitation.

7. Unless otherwise specified, motors rated 100 horsepower or greater located outdoors, in unheated structures, in below grade areas, or as otherwise indicated, shall be furnished with space heaters and embedded motor winding high temperature switches with leads brought out of the motor terminal box. Space heaters shall be suitable for 120VAC operation and for a maximum surface temperature of less than 200 degrees C. Spare heaters shall be of sufficient wattage to maintain the internal temperature of the motor at approximately 10 degrees C above the ambient temperature when the motor is not running.

   Embedded motor winding temperature switches shall operate at temperatures well below the temperature rating of the motor winding insulation system. Motor winding temperature switches are not required where other temperature monitoring devices (e.g. RTD's) are required.

8. Unless otherwise specified in the equipment specifications, motors rated 200HP or greater that are controlled by a VFD shall be furnished with resistance thermal detectors (RTD's) embedded in the stator windings, two per phase. RTD's shall be pre-wired to terminal blocks located in a separate terminal box as specified herein.

9. Unless otherwise specified in the equipment specifications, motors rated less than 200HP that are controlled by a VFD shall be furnished with motor winding high temperature switches embedded in the stator windings with the leads brought out to the motor terminal box.

10. If so specified and when located in indoor areas which are heated and weatherproof, motors shall be open drip-proof machines. Ventilation openings shall be arranged to prevent the entrance of drops of liquid or solid particles at any angle from zero to 15 degrees downward from vertical.

11. Unless otherwise specified, or required, motors rated less than 200 horsepower shall be furnished with bearings of the grease lubricated, antifriction ball type with conveniently located grease fittings and drain plugs. A means of preventing bearings from becoming overgreased shall be provided. Bearings shall have a minimum B-10 life of 20,000 hours.

12. Rotors shall be statically and dynamically balanced. Rotor windings shall be one-piece cast aluminum. Where applicable, rotors shall be constructed with integral fins.

13. Externally mounted motor shaft grounding rings shall be provided to protect motors against motor shaft and bearing currents. Grounding rings shall be provided for all motors controlled by VFDs, with the following exceptions:

    a. Motors located in hazardous areas
    b. Motors rated less than 1 horsepower
    c. Submersible motors

14. All motors shall be provided with factory-installed one-hole terminations (ring terminals) on the ends of all motor leads. Terminations shall be identified for use with cables that have stranding other than Class B, and shall be the irreversible compression type.

H. Power Factor and Efficiency

1. All motors, including vertical hollowshaft motors, in the range of 1-500 horsepower, inclusive, shall be designed specifically for energy efficiency and high power factor. The motor efficiency and power factor shall meet or exceed the values listed in the table below when the motors are tested in accordance with the NEMA preferred test method IEEE 112A, Method B, Dynamometer. Each motor shall meet the minimum guaranteed efficiency value indicated in the table below. All tests shall be performed in accordance with the procedures contained in NEMA Standard MG1-12.58.

TABLE 12-11 FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS ENCLOSED MOTORS								
	2 POLE		**4 POLE**		**6 POLE**		**8 POLE**	
HP	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**
1	75.5	72	82.5	80	80	77	74	70
1.5	82.5	80	84	81.5	85.5	82.5	77	74
2	84	81.5	84	81.5	86.5	84	82.5	80
3	85.5	82.5	87.5	85.5	87.5	85.5	84	81.5
5	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15	90.2	88.5	91	89.5	90.2	88.5	88.5	86.5
20	90.2	88.5	91	89.5	90.2	88.5	89.5	87.5
25	91	89.5	92.4	91	91.7	90.2	89.5	87.5
30	91	89.5	92.4	91	91.7	90.2	91	89.5
40	91.7	90.2	93	91.7	93	91.7	91	89.5
50	92.4	91	93	91.7	93	91.7	91.7	90.2
60	93	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75	93	91.7	94.1	93	93.6	92.4	93	91.7
100	93.6	92.4	94.5	93.6	94.1	93	93	91.7
125	94.5	93.6	94.5	93.6	94.1	93	93.6	92.4
150	94.5	93.6	95	94.1	95	94.1	93.6	92.4
200	95	94.1	95	94.1	95	94.1	94.1	93
250	95.4	94.5	95	94.1	95	94.1	94.5	93.6
300	95.4	94.5	95.4	94s.5	95	94.1		
350	95.4	94.5	95.4	94.5	95	94.1		
400	95.4	94.5	95.4	94.5				
450	95.4	94.5	95.4	94.5				
500	95.4	94.5	95.8	95				

TABLE 12-12
FULL-LOAD EFFICIENCIES FOR NEMA PREMIUM™ EFFICIENCY ELECTRIC MOTORS
RATED 600 VOLTS OR LESS (RANDOM WOUND)
OPEN MOTORS

	2 POLE		**4 POLE**		**6 POLE**	
HP	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**	**Nominal Efficiency**	**Minimum Efficiency**
1	77	74	85.5	82.5	82.5	80
1.5	84	81.5	86.5	84	86.5	81.5
2	85.5	82.5	86.5	84	87.5	81.5
3	85.5	82.5	89.5	84	88.5	86.5
5	86.5	84	89.5	84	89.5	87.5
7.5	88.5	86.5	91	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93	91.7	91.7	90.2
20	91	89.5	93	91.7	92.4	91
25	91.7	90.2	93.6	92.4	93	91.7
30	91.7	90.2	94.1	93	93.6	92.4
40	92.4	91	94.1	93	94.1	93
50	93	91.7	94.5	93.6	94.1	93
60	93.6	92.4	95	94.1	94.5	93.6
75	93.6	92.4	95	94.1	94.5	93.6
100	93.6	92.4	95.4	94.5	95	94.1
125	94.1	93	95.4	94.5	95	94.1
150	94.1	93	95.8	95	95.4	94.5
200	95	94.1	95.8	95	95.4	94.5
250	95	94.1	95.8	95	95.4	94.5
300	95.4	94.5	95.8	95	95.4	94.5
350	95.4	94.5	95.8	95	95.4	94.5
400	95.8	95	95.8	95	95.8	95
450	95.8	95	96.2	95.4	96.2	95.4
500	95.8	95	96.2	95.4	96.2	95.4

NOTES:

(1) Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating.

(2) TEFC efficiencies apply to both horizontal and vertical motors.

2. Motors rated 50 horsepower or greater shall be individually tested at the factory before shipment, with a copy of test results provided for the Engineer, to assure compliance with the efficiency and power factor specifications.

I. Power Factor Correction

1. The power factor shall be corrected as necessary to achieve 85% (minimum) with capacitors sized and installed per manufacturer's recommendations. Capacitors shall be installed such that the motor shall not be damaged by overvoltage or excessive transient electrical torque. The capacitor(s) shall be connected as close as possible or directly to the motor terminals. Any power factor corrections shall not decrease the motor efficiency below the stated minimum requirement of this Specification. All power factor corrections shall be noted on the Shop Drawings submitted to the Engineer for approval. POWER FACTOR CORRECTION, TO ACHIEVE 85%, SHALL BE PROVIDED ON ALL MOTORS ABOVE 15 HORSEPOWER EXCEPT FOR THOSE MOTORS CONTROLLED BY VARIABLE FREQUENCY DRIVES (VFD'S).

2. When required, power factor correction capacitors shall be connected on the line side of <u>any</u> type of reduced voltage starting motor controller (e.g. RVAT, RVSS, Part-Winding, Wye-Delta, etc.).

<u>PART 3 -- EXECUTION</u>

3.01 INSTALLATION

A. Motors shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

3.02 DELIVERY, STORAGE, AND HANDLING

A. Motors shall be properly protected from weather hazards. Motors shall not be allowed to be wrapped tightly in plastic while outdoors. Motors delivered to the site which will not be put in service for a time in excess of 30 calendar days, whether in storage or installed, shall have the shafts rotated a minimum of five (5) rotations every 30 days.

B. Motors provided with space heaters shall have temporary power applied to the heaters no later than 30 calendar days after delivery to the site until permanent power can be applied to the heaters.

C. Motors that, in the opinion of the Engineer, have not been properly protected shall be inspected by the manufacturer's representative. Any required electrical corrections for testing shall be made at the Contractor's expense prior to acceptance and/or use.

D. All motors shall operate without any undue noise or vibration and shall show no signs of phase unbalance.

3.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1S. The following tests are required:

1. Witnessed Shop Tests

   a. All motors shall be shop tested and inspected in accordance with the equipment manufacturer's standard procedures. Shop tests for motors 100 horsepower and larger may be witnessed by the Engineer. The manufacturer's testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified, all other applicable requirements, and shall be approved by the Engineer. At least 10 days notice shall be given the Engineer prior to tests and inspection dates.

   b. In addition to the efficiency and power factor testing specified herein, each motor shall be tested to determine compliance with the applicable requirements of the IEEE, ANSI and NEMA. Tests shall be as follows:

      (1) Motors less than 50 HP

         (a) Each motor shall be subjected to a standard, short commercial test including the following:

            i) Running current, no load
            ii) Locked rotor current
            iii) High potential
            iv) Winding resistance
            v) Bearing inspection

      (2) Motors between 50 and 100 HP

         (a) Each motor shall be subjected to the above tests and shall be furnished with certified test results.

      (3) Motors larger than 100 HP

         (a) Each motor shall be furnished with certified test results. Each motor shall be subjected to a complete test consisting of full load heat run, percent slip, running load current, locked rotor current, breakdown torque (calculated), starting torque, winding resistance, high potential, secondary current and voltage at collector rings (wound rotor), efficiencies at 100, 75 and 50 percent of full load, power factors at 100, 75 and 50 percent of full load and bearing inspection. Tests will be witnessed by the Engineer where specifically indicated.

      (4) Test Reports

         (a) All test results for motors over 100 horsepower shall be submitted to the Engineer for approval. Copies of witnessed test raw data shall be submitted to the Engineer immediately upon completion of such tests.

2. Field Tests

a. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 1S, and Section 16000S, Basic Electrical Requirements.

b. All electric motors furnished for this project one (1) horsepower or larger shall have the information required in the following tabulation completed. See Exhibit "A" on following page.

c. All field testing shall be witnessed by the Engineer.

(EXHIBIT A)

MOTOR TEST RECORD					
Motor Identification Remarks	Location	Specified Horsepower	Nameplate Horsepower	Nameplate Amperage (FLA)	Measured Amperage Under Normal Operating Conditions

- END OF SECTION -

SECTION 16000S

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental, to the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.

B. Reference Section 17000S, Control and Information System Scope and General Requirements for scope of work details as they relate to the Division 17S Subcontractor.

C. The electrical scope of work for this project primarily includes, but is not limited to, the following:

1. Power distribution, overcurrent protection devices, electrical raceways, terminal boxes, lighting, switches, receptacles and other electrical devices required for the proper operation and maintenance of the Sidestream Ammonia Removal System as specified in Division 11S.

2. Electrical equipment as specified in Division 16S and other Divisions.

3. Coordination with the installing electricians providing external connections to specified electrical equipment.

4. Electrical testing, control system testing and other services that may be specified in these documents.

5. Electrical and control system training as may be described in these specifications.

D. All material and equipment must be the product of an established, reputable, and approved manufacturer; must be new and of first class construction; must be designed and guaranteed to perform the service required; and must bear the label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.

E. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.

F. Where the Contractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.

G. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.

1.02 EQUIPMENT LOCATION

A. Contractor-submitted Drawings shall clearly indicate locations of all Contractor provided electrical equipment including recommended connection points to electrical connection provided by Others.

1.03 LOCAL CONDITIONS

A. The Contractor shall examine the site and become familiar with conditions affecting the work. Proposed locations of both temporary and permanent equipment shall be approved by the Owner.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions, Section 01302S, Submittals and the requirements of the individual specification sections, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings
2. Operation and Maintenance Manuals
3. Spare Parts List
4. Proposed Testing Methods and Reports of Certified Shop Tests.
5. Reports of Certified Field Tests.
6. Manufacturer’s Representative’s Certification.

B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements. Control panel and other wiring diagrams shall be of sufficient detail and quality that they may be used as working drawings for the installing technicians.

C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.

D. Some individual Division 16S specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

1.05 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the following:

   a. Insurance Rating Organization having jurisdiction
   b. The serving electrical utility company
   c. The currently adopted edition of the National Electrical Code (NEC)
   d. The National Electric Manufacturers Association (NEMA)
   e. The Institute of Electrical and Electronic Engineers (IEEE)
   f. The Insulated Cable Engineers Association (ICEA)
   g. The American Society of Testing Materials (ASTM)
   h. The American National Standards Institute (ANSI)
   i. The requirements of the Occupational Safety Hazards Act (OSHA)
   j. The National Electrical Contractors Association (NECA) Standard of Installation
   k. National Fire Protection Association (NFPA)
   l. International Electrical Testing Association (NETA)
   m. All other applicable Federal, State and local laws and/or ordinances.

2. All material and equipment shall bear the inspection labels of Underwriters Laboratories, Inc., if the material and equipment is of the class inspected by said laboratories.

B. Nonconformance

1. Any paragraph of requirements in these Specifications, or Drawings, deviating from the rules, requirements and Specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules, requirements and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or Specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

1.06 MATERIALS HANDLING

A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be temporarily connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01550, Site Access and Storage.

1.07 WARRANTIES

A. Unless otherwise specified in an individual specification section, all equipment and electrical construction materials furnished and installed under Division 16S shall be provided with a warranty in accordance with the requirements of Section 11000S and the General Conditions.

1.08 TRAINING

A. Unless otherwise specified in an individual specification section, all training for equipment furnished and installed under Division 16S shall be provided in accordance with the requirements of Section 11000S, Sidestream Deammonification System.

PART 2 -- PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical

Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.

C. All equipment and materials shall be new, unless indicated or specified otherwise.

D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc., in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming to this requirement.

2.02 SUBSTITUTIONS

A. Unless specifically noted otherwise, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition. The Contractor, in such cases may, at his option use any article, device, product, material, fixture, or item of equipment which in the judgment of the Engineer, expressed in writing, is equal to that specified.

PART 3 – EXECUTION

3.01 COORDINATION AND CERTIFICATION

A. Coordination

1. The Contractor shall maintain oversight of electrical and control work performed by the installing technicians. Contractor shall verify work is performed in accordance to the Contractor’s installation recommendations.

B. Damage

1. Damage to new or existing equipment shall be brought to the attention of the Owner.

- END OF SECTION -

SECTION 16161S

PLC TERMINATION CABINETS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The requirements of this section shall apply to the general construction contractor for the Expansion Project. This section serves as a reference for components supplied by the Offeror. Loudoun Water will not directly award a purchase order for the goods and associated services for the Expansion Project but will instead assign the Procurement Agreement to the general construction contractor selected for the Expansion Project.

B. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all PLC (Programmable Logic Controller) termination cabinets as required for a complete installation as specified herein and indicated on the Drawings.

C. The termination cabinets shall be furnished with numbered terminals for wiring connections by others between the termination cabinets and the PLC's. The Contractor shall provide all conduit and wire for each input and output (I/O) wiring point as specified in the I/O list, indicated on the Drawings, and as required.

D. Coordination

1. The Contractor shall review installation procedures under other Divisions and coordinate them with the Work specified herein.

2. The Contractor shall notify others in advance of the installation of the Work included herein to provide them with sufficient time for the coordination and installation of interrelated items that are included in the Contract and that must be installed in conjunction with the Work specified in this Section.

3. The Contractor shall coordinate the work described in this Section with that to be completed by the Instrumentation Subcontractor.

4. The Contractor shall submit the shop drawings specified herein for approval.

E. The PLC termination cabinets shall conform to all applicable Federal, UL, and NEMA standards. Materials and components shall be new and conform to grades, qualities and standards as specified herein and shown on the Drawings.

F. Reference Section 16000S, Basic Electrical Requirements; Section 16902S, Electric Controls and Relays; and the applicable sections of Division 17S, Control and Information Systems.

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1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1S. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Certified Shop Tests and Reports

a. None required.

3. Field Tests

a. Field testing shall be performed in accordance with the requirements specified in the General Conditions, Division 1S, and Section 16000S, Basic Electrical Requirements.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01302S, Submittals, the Contractor shall obtain from the equipment manufacturer(s) and submit the following:

1. Shop Drawings

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible Submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Material specifications and product data sheets.

2. Plan, front, and side view drawings, including overall dimensions of <u>each</u> termination cabinet.

3. Complete assembly, layout, and installation drawings for <u>each</u> termination cabinet with clearly marked dimensions.

4. Complete terminal strip wiring diagrams showing terminal strip and individual terminal identification. Diagrams shall indicate the wiring to be connected to each terminal and the wiring's respective device/tag number (e.g. FIT-XXX, PSH-XXX).

5. Approximate total shipping weight.

6. Bill of material list for <u>each</u> termination cabinet.

D. Shop drawings shall be submitted after approved shop drawings have been received and updated by the Contractor.

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 IDENTIFICATION

A. Each termination cabinet shall be identified with the identification number indicated on the Drawings (e.g., TC1, TC2). A nameplate shall be securely affixed in a conspicuous place on each termination cabinet. Nameplates shall be as specified in Section 16195S, Electrical - Identification.

<u>PART 2 -- PRODUCTS</u>

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 ENCLOSURES

A. Termination cabinets shall be free standing, double door NEMA 12 (minimum) with back panel. The cabinet shall be fabricated from minimum 12 gauge steel with seams continuously welded and ground smooth. Doors shall overlap to eliminate the center post, and shall be gasketed and be provided with a three point mechanism operated by oil tight key-locking handle. Doors shall have heavy gauge continuous hinges. Latching rods shall have rollers for easier door closing. Enclosures shall be manufactured by Hoffman Engineering Company, Rittal Corporation, The Austin Company, or equal.

B. Copper ground lug(s)/bus shall be furnished and installed in the cabinet to allow termination of the equipment grounding conductor to effectively ground the cabinet.

C. Each termination cabinet shall be furnished with a single lamp, open, fluorescent light fixture with respective SPST light switch and one duplex convenience outlet. These loads shall be powered from a separate 120 VAC circuit from the nearest lighting panelboard.

D. Cabinets shall be 48"(W)X24"(D)X90"(H) (maximum).

2.03 TERMINALS

A. Terminals shall be as specified in Section 16902S, Electric Controls and Relays.

B. Provide 10% numbered spare terminals.

2.04 WIRING DUCT

A. Each cabinet shall be provided with the terminal strips separated by plastic (PVC) wiring duct. Two systems of wiring duct shall be provided, one for field wiring to cabinet terminals and one for wiring from cabinet terminals to the PLC. The wiring duct from cabinet terminals to the PLC shall be left empty for use by others. Plastic wiring duct shall be of the snap in slot design furnished and installed with covers as manufactured by Panduit, or equal.

B. Each cabinet shall be designed and fabricated to provide separation of analog, discrete, and power wiring. Wiring duct and terminal strips shall be furnished and installed in each cabinet to allow this separation.

2.05 WIRE IDENTIFICATION

A. All digital and analog signal wires, shall be labeled with their appropriate tag number from the I/O schedule (five digits plus prefix of suffix letter) for ease of identification.

B. Wire identification shall be accomplished through the use of a portable printer and white, polyolefin wire marking sleeves. The wire identification system shall be a "Bradymarker" XC Plus Printer with "Bradysleeve" wire marking sleeves, Panduit equivalent, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The PLC termination cabinets shall be furnished and installed on concrete pads in the locations as indicated on the Drawings.

B. All spare field conductors routed to the termination cabinet shall be identified and terminated on their respective spare terminals. Coiling of cables left in the bottom of the enclosure is not acceptable.

C. Terminations of all control and instrument wire at PLCs and remote IO equipment shall be provided with insulated collar crimp-type ferrules. Ferrules shall be UL-486A listed, and properly sized for the conductor to which it is terminated.

3.02 PAINTING

A. Prior to final completion of the work, all metal surfaces of the termination cabinets shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.03 DIRECTORIES

A. Each termination cabinet shall be provided with a minimum of four typed directories indicating tag number, terminal strip and terminal number, I/O point description, point/signal type, and PLC/TC number for each terminal in the cabinet. See Exhibit A included in this Section which includes sample information for reference only.

(EXHIBIT A) PLC/TC TERMINATION CABINET DIRECTORY PLC/TC NO. _______________				
TAG NUMBER	**DESCRIPTION**	**TYPE**	**TERMINAL STRIP NUMBER**	**TERMINAL NUMBER**

- END OF SECTION -

SECTION 16195S

ELECTRICAL - IDENTIFICATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All switchgear, switchboards, motor control centers, variable frequency drives, lighting and distribution panelboards, combination starters, control panels, pull and junction boxes, enclosures, disconnect switches, control stations, and similar equipment shall be identified in the manner described, or in an equally approved manner.

B. The types of electrical identification specified in this section include, but are not limited to, the following:

1. Operational instructions and warnings.
2. Danger signs.
3. Equipment/system identification signs.
4. Nameplates.

1.02 LETTERING AND GRAPHICS

A. The equipment tagging scheme for the sidestream deammonification equipment and ancillary equipment will be developed during the concurrent sidestream deammonification system design. Equipment tag information shall be provided during the installation phase of this project.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01302S, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

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C. Shop drawings shall include but not be limited to:

1. Product data sheets.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The material covered by these Specifications is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

2.02 NAMEPLATES

A. Nameplates shall be engraved, high pressure plastic laminate, white with black lettering.

B. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or equal.

2.03 CONDUIT IDENTIFICATION

A. Identification shall be by means of an adhesive label with the following requirements:

1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.

2. For conduits trade sizes 3/4 inch through 1-1/2 inch, the text shall be a minimum 18 point font. For conduits trade size 2 inch and larger, the text shall be a minimum 24 point font.

3. Label height shall be 3/4 inch minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.

4. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.

5. Labels shall be made of permanent vinyl with adhesive backing. Labels made of any other material are not acceptable.

2.04 WIRE AND CABLE IDENTIFICATION

1. Wire identification shall be by means of a heat shrinkable sleeve with appropriately colored background and black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a

minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.

2. Sleeves shall be suitable for the size of wire on which they are installed. Sleeves shall not be heat-shrunk onto control cables. Tags shall remain loose on cable to promote easier identification. For all other applications, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.

3. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.

4. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.

PART 3 -- EXECUTION

3.01 NAMEPLATES

A. Nameplates shall be attached to the equipment enclosures with (2) two stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

3.03 POWER SOURCE IDENTIFICATION

A. After installation of all field equipment (i.e. valves, motors, fans, unit heaters, instruments, etc) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC number, panelboard, etc), circuit number, conduit number from schedule and voltage/phase.

B. Contractor to coordinate with the Engineer and the Owner regarding exact nameplate placement during construction.

C. Nameplates shall be as specified herein.

- END OF SECTION -

SECTION 16476S

ENCLOSED CIRCUIT BREAKERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The requirements of this section shall apply to the general construction contractor for the Expansion Project. This section serves as a reference for components supplied by the Offeror. Loudoun Water will not directly award a purchase order for the goods and associated services for the Expansion Project but will instead assign the Procurement Agreement to the general construction contractor selected for the Expansion Project.

B. The Contractor shall furnish and install enclosed circuit breakers of voltage and current ratings as specified herein and indicated on the Drawings.

C. This specification is intended to apply to circuit breakers separately-mounted from other equipment in an individual enclosure. This Section does not apply to circuit breakers as part of an equipment assembly such as motor control centers, panelboards, switchboards, etc.

D. Reference Section 16000S, Basic Electrical Requirements.

1.02 CODES AND STANDARDS

A. Enclosed circuit breakers shall comply with the following codes and standards:

1. UL 489 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

2. NEMA 250 – Enclosures for Electrical Equipment

3. National Electrical Code

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01302S, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts List.

3. Operation and Maintenance Manuals.

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each enclosed circuit breaker.

1.05 SPARE PARTS

A. For each enclosed circuit breaker, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer.

1.06 IDENTIFICATION

A. Each enclosed circuit breaker shall be identified with the identification name and/or number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on the front of each enclosed circuit breaker. Nameplates shall be as specified in Section 16195S, Electrical - Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Enclosed circuit breakers shall be manufactured by Eaton, the General Electric Company, the Square D Company, or Siemens Energy and Automation, Inc.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Circuit breakers shall be molded case type with trip and frame ratings as indicated on the Drawings. Provide electronic trip unit where indicated on the Drawings, with adjustable functions as indicated on the Drawings.

B. Circuit breakers shall have an interrupting rating of 65,000 amperes symmetrical at 480 VAC, unless otherwise indicated on the Drawings.

C. Enclosed circuit breakers in non-hazardous locations shall be UL 489 Listed. Circuit breakers in hazardous locations shall be UL 1203 Listed.

D. In non-hazardous locations, enclosed circuit breakers shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	**ENCLOSURE TYPE AND MATERIAL**
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

E. In hazardous locations, enclosed circuit breakers shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	**ENCLOSURE TYPE AND MATERIAL**
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

F. Enclosed circuit breakers shall be quick-make, quick-break and with an interlocked cover which cannot be opened when the breaker is in the “ON” position and capable of being locked in the “OPEN” position.

G. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the enclosure.

H. Enclosed circuit breakers shall be suitable for use as service entrance equipment where indicated on the Drawings and so labeled to suit the application.

I. Where indicated on the Drawings, enclosed circuit breakers shall be 100% rated.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The enclosed circuit breaker shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.

B. Enclosed circuit breakers shall be set true and plumb in locations as shown on the Drawings. The top of enclosure shall not exceed six (6) feet above finished floor elevation.

C. Enclosed circuit breakers shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1S. The following tests are required:

1. Witnessed Shop Tests

   a. None required

2. Field Tests

   a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1S, and NETA Acceptance Testing Specifications, latest edition.

- END OF SECTION -

SECTION 16495S

VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor (general contractor awarded the Expansion Project) shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all variable frequency drives (VFD's) as shown on the Drawings and specified herein.

B. Reference Section 16000S, Basic Electrical Requirements, Section 16482, Low Voltage Motor Control Centers, Section 16902S, Electric Controls and Relays, and Section 17900, Schedules and Control Descriptions, General.

1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1S. The following tests are required:

1. Witnessed Shop Tests

a. The VFD's specified in this Section shall be witness shop tested and inspected in accordance with the equipment manufacturer's standard procedures. The testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified and shall be approved by the Engineer. At least 10 days notice shall be given the Engineer prior to such tests and inspection dates.

b. Factory test the complete variable frequency drive system in accordance with IEEE and NEMA standards with these Specifications. In addition, the variable frequency drive system shall be tested for efficiency as defined in this Specification and for operational integrity during output short circuit conditions. Short circuit test shall demonstrate that the equipment will successfully protect against and survive a minimum of three (3) successfully repeated phase-to-phase short circuits at the drive output terminals.

c. Variable frequency drive system components, including power transistors, GTOs, SCRs, IGBT's, diodes shall be 100 percent inspected and tested, including temperature cycling and inspected and tested including temperature cycling and ambient high temperature of 65 degrees Celsius load testing. All integrated circuits shall be inspected, pass/fail tested, temperature cycled and ambient high temperature tested. Small components, including small signal semiconductors, resistors, capacitors, diodes, etc. shall be lot sampled and tested for functionality. Test printed circuit boards under a temperature cycled 20 hour load test and functionally bench test prior to unit installation. Inspect all final assemblies and test at full load with application of line-to-line and line-to-ground bolted faults. The variable frequency drive system shall electrically trip off line under these conditions without device failure.

d. After the specified inspections and tests have been successfully completed, the variable frequency drive system shall undergo an 8 hour burn-in test. Burn system in at 100 percent inductive or motor load for 40 hours without an unscheduled shutdown.

2. Certified Shop Tests and Reports

a. Submit description of proposed testing methods, procedures, and apparatus.

b. Submit notarized and certified copies of all test reports.

c. Submit factory bench-test data to indicate that the manufacturer's proposed equipment has been tested in the specified arrangement and found to achieve specified accuracy.

3. Field Tests

a. Field tests shall be performed in accordance with requirements specified in the General Conditions, Division 1S, and Section 16000S, Basic Electrical Requirements.

B. Authorized representatives of the Owner shall be allowed free access to the shop at all times while work is in progress for the purpose of inspection, witnessing of tests, and obtaining information on the progress of the work. The Owner shall give the Contractor 72 hours prior notice.

C. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the Contractor of responsibilities.

D. The Contractor shall successfully complete acceptance test procedures on the assembled drive system that demonstrate compliance with the requirements of this Specification. The test plan shall be submitted for acceptance at least 30 days prior to the planned test date.

E. Drive system shall not be shipped from the manufacturing and assembly facility until the acceptance tests are completed and the acceptance tests are completed and the results approved by the test representative.

F. Tests shall be witnessed by a representative of the Engineer. Variable frequency drive manufacturer shall notify the Engineer 2 weeks in advance and shall provide testing procedures to the Engineer 4 weeks prior to actual testing. Failure of a test shall result in rejection of the equipment until performance is in compliance with these Specifications.

G. Certification on materials and records of shop tests necessary for the inspector to verify that the requirements of the Specifications are met, shall be made available to the inspector.

H. Submit signed and dated certification that all of the factory inspection and testing procedures described herein have been successfully performed by the Contractor prior to shipment.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in General Conditions and Section 01302S, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Harmonic Study Report

3. Programming Guides/Manuals

4. Operation and Maintenance Manuals

5. Spare Parts List

6. Special Tools List

7. Shop Test Plan

8. Reports of Certified Shop and Field Tests

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.

D. Shop drawings <u>for each VFD</u> shall include but not be limited to:

1. Layout drawings of the variable frequency drive system that include all cabinet or enclosure dimensions, access details, and weights.

2. Layout drawings of panels or enclosures showing size, arrangement, color, and nameplates. Drawings shall include the physical arrangement of door mounted devices located on the variable frequency drive enclosure. Sufficient detail shall be provided for locating conduit stub-ups. General "catalog data sheet" layout drawings which are not specific to the systems specified herein are not acceptable.

3. Custom schematic and interconnection wiring diagrams of all electrical work, including terminal blocks and identification numbers, wire numbers and wire colors. Standard schematics and wiring diagrams that are not custom created by the manufacturer for the variable frequency drives for this project are not acceptable. These drawings shall be circuit specific for each motor-load combination (e.g. influent pumps, RAS pumps, effluent pumps, raw water pumps, etc.). Indicate all devices, regardless of their physical location, on these diagrams. Specific equipment names consistent with the Drawings shall appear on each respective diagram.

4. Complete single line diagrams indicating all devices comprising the variable frequency drive system including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system. Electrical ratings of all equipment and devices shall be clearly indicated on these single line diagrams.

5. Complete Bills of Material and catalog data sheets for all equipment and devices comprising the variable frequency drive system.

6. A complete list of recommended spare parts, including item descriptions, recommended quantities, and unit costs. The recommended list should be based on a maintenance plan where the Owner will remove and replace failed items to the lowest replaceable module/component level.

E. The shop drawing information shall be completed and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

F. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "<u>as-built</u>" wiring diagrams for each VFD and bypass starter. These final drawings shall be plastic laminated and securely placed inside each VFD and starter door and included in the O&M manuals.

G. Product Data shall include, but not be limited to:

1. Functional diagrams that identify major system functional blocks and interfaces.

2. Special requirements or restrictions of the motor-load combination that may result from operation on the variable frequency drive system.

H. Harmonic Study and Data shall include but not be limited to:

1. Report of Harmonic Study to determine the harmonic distortion present in the voltage and current waveforms on motor terminals and in the electrical distribution system(s) caused by the variable frequency drive system as specified herein.

2. Voltage and current waveforms supplied by variable frequency drive at the motor leads.

3. Necessary descriptions regarding calculation method, assumptions, values and notations, basis for input information, manufacturer's harmonic content data, and calculation results interpretation.

I. Programming Guides and Manuals shall be submitted. If the variable frequency drive systems require computer software or configuration, provide copies of all programming guides/manuals. Flow charts and listings of software developed shall be submitted to the Engineer. Submit final flow charts and program listings no later than 6 weeks prior to factory testing of the system.

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions, Section 01302S, Submittals and Section 11000S, Equipment - General Provisions.

B. Operation and Maintenance Manuals shall also be provided in electronic format on CDROM.

1.06 TOOLS, SUPPLIES, AND SPARE PARTS

A. The VFD's and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.

B. The Contractor shall furnish the following spare parts <u>for each VFD</u>:

1. One set of all power and control fuses for each variable frequency drive.

2. One fully functional main control circuit board for each variable frequency drive.

3. One of each inverter power semiconductor for each rating supplied for each variable frequency drive.

4. Spare auxiliary equipment as specified in Article 2.10.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.

E. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Manufacturer’s field services shall be in accordance with Specification 11000S and as specified herein. The Contractor shall provide the services of a qualified, factory-trained manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing, in accordance with Specification 11000S Equipment General Provisions that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.

B. The manufacturer’s technical representative shall perform testing and startup in accordance with Section 11000S and as specified herein.

C. The Contractor shall provide training for Owner personnel in accordance with Section 11000S. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner personnel in operation and maintenance of <u>all equipment provided under this Section</u>.

D. At a minimum, the number of days indicated below shall be provided on an 8-hour-day on-site basis and shall be in addition to travel time. The number of days at the site shall be increased as necessary, without change to the proposal price or schedule, to accomplish the Work of this Section. Minimum service durations by the manufacturer are as follows:

Service	**Number of Trips**	**Number of Days/Trip**
Installation Supervision	2	1
Functional Testing	2	1
Performance Testing	2	1
Reliability Demonstration Testing	2	1
Warranty Check (2 months prior to warranty expiration)	1	1

E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

F. A written report covering the manufacturer’s representative's findings at each visit and at installation approval shall be submitted to the Engineer. The report shall cover all inspections and shall outline in detail any deficiencies noted and all corrective measures taken or recommended.

1.08 IDENTIFICATION

A. Each VFD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each VFD. Nameplates shall be as specified in Section 16195S, Electrical - Identification.

1.09 TRAINING

A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section.

B. Provide the services of an experienced, factory trained technician or service engineer of the variable frequency drive manufacturer at the jobsite for minimum of 3 days for training of Owner personnel, beginning at a date mutually agreeable to the Contractor and the Owner. The technician shall be on duty at the site for at least 8 hours per day and shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.

C. Include in the bid the training of personnel in the operation and maintenance of each furnished variable frequency drive pump control system. For the purpose of this training section of the Specifications, a system is by definition a group of pumps or equipment which all serve a common function (e.g. influent pumps, RAS pumps, effluent pumps, raw water pumps, etc.). Training shall include at least one session for 2 designated employees for each system.

1.10 WARRANTY

A. Contractor shall warrant that the material and workmanship of all components and the operation of the variable frequency drive system and auxiliary equipment is in accordance with the latest design practices and meets the requirements of this Specification.

B. Warranty work shall include, but not be limited to, the following:

1. Replace components found to be faulty and make changes in equipment arrangement or adjustments necessary to meet the equipment or functional requirements or this Specification.

2. Warranty shall include system rewiring and substitution and rebuilt or additional equipment required during trial operation or subsequent operation of the unit during the period of this warranty.

3. Warranty shall be in effect for a period of 24 months following the issuance of an Owner issued Certificate of Substantial Completion, which specifically includes work associated with equipment and materials covered under this specification,

1.11 CONSTRUCTION SEQUENCING

A. The Contractor shall reference Section 01150, Sequence of Construction, of these Specifications.

<u>PART 2 -- PRODUCTS</u>

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that the VFD's be provided as part of the motor control center equipment.

C. The Contractor shall obtain the VFD's from one manufacturer who shall also manufacture the enclosure and major equipment components. The manufacturer shall have a minimum of five years experience in the manufacture of similar units and shall have a general distribution to the electrical trade. Subcontracting of wiring will not be acceptable.

The VFD's shall be as manufactured by Allen Bradley and shall be furnished complete with bypass starters, harmonic distortion suppression equipment, and all other equipment specified herein and indicated on the Drawings for a complete and operable system. The reduced voltage, auto-transformer (RVAT) starters shall be by the same manufacturer as the motor control centers for the project.

D. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard three-wire "start-stop" and the Contractor shall furnish wiring accordingly.

E. Variable frequency drive manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all load, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.

F. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.

2.02 PRODUCT REQUIREMENTS

A. Variable speed drives shall be adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 480 volt AC NEMA Design B induction motors. Variable frequency drives for other than NEMA Design B induction motors (e.g. NEMA Design C) shall be coordinated with the requirements of that respective load.

Drive units shall perform continuous self diagnostics as well as load and drive self check on startup.

B. All drives shall have permanently mounted programming and display modules. These modules shall provide programming access to all drive parameters, display all fault codes to assist with diagnostics and provide a display of output speed in percent or load.

C. This specification describes variable speed motor control which includes the design, fabrication, testing, installation and support requirements for variable frequency drive systems for 3-phase, squirrel cage rotor, induction motors driving pumps or other equipment. In addition to the variable frequency drive system, provide a motor controller for bypass starting during variable frequency drive downtime, where specified herein and indicated on the Drawings.

D. Each variable frequency drive to be a complete alternating current electric drive system including hardware, software, technical data, and spare parts necessary to accomplish variable speed operation of an induction motor and load combination in accordance with the requirements as indicated on the Drawings and as described in these Specifications. Contractor shall refer to Section 17900 of the Specifications for a functional control description of each variable frequency drive system.

E. Variable frequency drive system manufacturer shall be responsible for the design and performance of the entire drive system and shall either manufacture all items of equipment or supply them using coordinated specifications furnished to the original equipment manufacturers to insure compatibility and performance in accordance with this Specification. Variable frequency drive manufacturer shall coordinate with suppliers of the drive motors and driven equipment. Motors shall be as specified in Section 15170S and other specific equipment Sections of the Specifications.

F. Variable frequency drive system shall be suitable for operation as part of a 480 VAC, 3-phase, 60 Hertz power distribution system. The complete variable frequency drive system shall withstand the mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.

G. The variable frequency drive system shall be suitable to operate, at times, on a limited power source engine-generator set. The system shall be provided with equipment and devices to prevent waveform distortion as specified herein.

H. Provide control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks.

I. Design each variable frequency drive motor drive speed control system so that through simple programming by either factory engineers or Owner's trained operating personnel, specific control and protection functions can be attained.

2.03 DESIGN REQUIREMENTS

A. Each variable frequency drive system shall meet the requirements of this Specification without derating any of the induction motor operating parameters including service factor and nameplate horsepower. The variable frequency drive system manufacturer shall specifically identify special requirements or restrictions of the motor-load combination that may result from operation on the variable frequency drive system.

B. The variable frequency drive shall consist of a 6, 12 or 18 pulse diode semiconductor rectifier system, direct current link, and pulse width modulated inverter. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the induction motor at the desired speed.

C. Variable frequency drive shall operate from fixed frequency power supply and convert this input power into variable speed induction motor shaft power as required by this Specification. Provide each variable frequency drive with a motor circuit protector as indicated on the Drawings which shall be padlockable. Provide each variable frequency drive with 5% line reactors at the input. Include the necessary drive controllers and output contactors to accomplish the intended control of the variable frequency drive system.

D. The drive shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.

E. The overall drive system efficiency shall be a minimum of 95 percent when operating the specified motor-load combination at rated voltage, frequency, and current.

This efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$

F. Power (Load) is the total 3-phase power delivered to the motor, measured at the output terminals of the drive system, including output filters or transformers. Power (Supply) is the total electrical power delivered to the drive system, measured at the input terminals of the variable frequency drive including input filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment. Include power input required for auxiliary equipment (e.g., controls, fans, air conditioning, pumps) for complete system operating in this Power (Supply) total.

G. Variable frequency drive shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed (revolutions per minute). The variable frequency drive shall be provided with maximum and minimum frequency limits.

H. Variable frequency drive system to maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5 percent of rated frequency of 60 Hertz for a 24 hour period.

I. Variable frequency drive to have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The variable frequency drive shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.

Variable frequency drive shall be furnished with programmable electronic overload and torque limits.

J. Drive system shall achieve a desired output frequency (setpoint) with a repeatability of 0.1 percent of rated frequency of 60 Hertz.

K. Drive system to be capable of operating the specified load continuously at any speed within the operating speed range of 10 percent to 100 percent of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.

L. Drive system controls to be microprocessor-based and have controlled linear acceleration capability to ramp up the speed, revolutions per minute, of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Provide two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. Provide controlled linear deceleration capability. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.

M. Voltage or current unbalance between phases of the variable frequency drive output voltage shall not exceed 3 percent of the instantaneous values. The variable frequency drive system shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3 percent. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.

N. Variable frequency drive system to operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10 percent for a duration of 15 cycles. Unacceptable voltage fluctuations on the supply bus shall cause under or overvoltage protection to trip and remove supply voltage from the drive system. Variable frequency drive output voltage regulation shall be plus or minus 2 percent.

The variable frequency drive system shall be furnished with line surge protection.

O. The Contractor shall size variable frequency drive system and components to provide, indefinitely, motor load current equal to 125 percent of the motor nameplate full load current.

The Contractor is fully responsible for the review of the mechanical specifications to determine specified motor speed, horsepower and full load amperes. This information is available in the applicable mechanical specifications for each pump, drive, conveyor, blower, etc. Reference the Table of Contents.

P. The audible noise (sound pressure) level of a motor when operated from no load to full load with the variable frequency drive described herein shall not increase more than 5 decibels (dbA), at 5 feet in any direction from the motor, above its noise level when operated from a utility power source without the variable frequency drive.

Q. Variable frequency drives shall be provided with output reactors or filters to prevent elevated voltage levels at the motor terminals.

2.04 OPERATING CONDITIONS

A. The following operating conditions are applicable for all equipment of this Specification.

1. Humidity: 0-95 percent.

2. Ambient Temperature: Minus 20 degrees Celsius to plus 50 degrees Celsius.

3. Altitude: up to 3,300 feet

4. Power Supply: 480 volts, 3-phase, 60 Hertz.

5. Available Short Circuit Duty: as specified herein.

B. Enclosure space heaters shall be tubular type operated at half voltage for long life; 500 volt or 250 volt rated heaters shall be used at 240 volt or 120 volt, respectively. The space heaters shall be powered from the controller's control power transformer. Heaters to be wired to provide temporary heating during storage.

2.05 SYSTEM FEATURES AND CHARACTERISTICS

A. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings. As a minimum, each VFD shall provide indication of the following:

1. Digital Speed Indicator: Revolutions per minute (input from tachometer).

2. Variable Frequency Drive Mode Indicator: Red; as required.

3. Bypass Mode Indicator: Red; as required;

4. Input Voltage

5. Output Voltage

6. Output Current

7. Output Frequency

8. Output Speed: 0-100%

9. Drive Ready Indicator: White

10. Run Indicator: Red.

11. Stop Indicator: Green.

12. Running Time Meter.

13. Enclosure Overtemperature.

14. Alarm Indicator: Amber.

15. Alarm Read-out: Display.

B. Each VFD shall provide the following automatic and manual controls:

1. Hand-Off-Auto Selector Switch (as required).

2. Start and Stop pushbuttons (as required).

3. VFD - Bypass Selector Switch (as required).

4. Local - Remote Speed Control Selector Switch (as required).

5. Local Speed Potentiometer.

6. Alarm Reset Pushbutton.

7. 24 VDC coil pilot relay for remote run command.

8. Alarm auxiliary contacts and other devices as indicated on the Drawings and specified.

9. Provision for a run permissive from other equipment when the drive is in "Auto".

C. Each VFD shall provide "potential-free" output contacts for the following conditions:

1. Drive running.

2. Drive in "Auto" and all trip conditions cleared.

Pilot devices shall be as specified in Section 16902S, Electric Controls and Relays.

D. Variable frequency drive system shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback or control and remote speed indication.

E. Variable frequency drive system shall accept a 4-20 mADC input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed, revolutions per minute, equal to or less than 0.1 percent of rated speed.

Each VFD shall be furnished with one 0-5A current transformer (CT) and a respective current transducer to provide an analog 4-20 mADC signal to a programmable logic controller. This analog signal shall be proportional to the load current output from the VFD to the motor for one phase (e.g. Phase C). The current transducer shall be rated for operation on a 120 VAC control power supply and shall be designed to accept a current input with a minimum frequency of 30 Hz.

F. When operating in the automatic mode, the variable frequency drive system shall shut down during a power outage. Upon restoration of normal power and after an adjustable time delay (0-2 minutes; motor has coasted to zero speed and there is no backspin), the variable frequency drive system shall automatically restart and then ramp up to speed as required by the control system. The process operator shall not be required to reset the system manually after a shutdown caused by a power outage.

G. Variable frequency drive shall be furnished with a multiple attempt restart feature.

H. Furnish a door mounted selector switch or other pilot device for those variable frequency drives where an additional speed reference signal (e.g., from a remote potentiometer, an analog output from a setpoint (PID) controller, an analog output from a programmable logic controller, or similar analog signal) is to be supplied to the variable frequency drive in addition to the door mounted manual speed control.

I. Provide a motor circuit protector with shunt trip coil and current-limiting fuses for each variable frequency drive. Provide each variable frequency drive with its respective drive controller and output contactors for each motor.

J. Include in each variable frequency drive system an automatic trip feature which will open the output contactor and remove the drive output from the motor and allow it to decelerate safely. This automatic system shall trip and indicate the fault only upon the following conditions:

1. Output voltage unbalance (trip threshold field set).
2. Open phase.
3. Motor overload.
4. Motor stator winding fault (phase-to-ground, phase-to-phase).
5. Loss of input power to the variable frequency drive or unacceptable voltage variation.
6. High variable frequency drive equipment temperature.
7. Variable frequency drive system failure as determined by the manufacturer.
8. Component failure.
9. Overcurrent.
10. Undercurrent.

K. Provide variable frequency drive system with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the drive controller as standard, this feature shall be capable of being disabled.

L. Variable frequency drive design shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure which in turn affects motor operation and generates an alarm contact output rated for 125 VDC suitable for interfacing with the control system.

1. Diagnostics shall operate a visual alarm indicator that is visible on the variable frequency drive equipment cabinets without opening the cabinet doors.

2. Diagnostics shall provide an easily readable output that will isolate a failure.

3. Provide an event and diagnostic recorder to printout in narrative English of the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.

4. Provide a normally open dry contact for each alarm function to enable remote indication. A communication port shall be provided for possible future link to the plant control system.

2.06 MOTOR PROTECTION

A. Provide motor protective relays and mounting as indicated on the drawings. The relay protective and monitoring functions shall be completely integrated into the variable frequency drive system. The motor protection device shall be a General Electric Company/Multilin Model SR469, or equal.

2.07 ENCLOSURES

A. Unless otherwise specified or indicated on the Drawings, the variable frequency drive enclosures shall be NEMA 12, force ventilated, dead-front, with front accessibility. VFDs integrated into motor control center structures shall meet the enclosure requirements for MCCs as specified in Section 16482, Motor Control Centers. Design enclosures for both bottom and top entry of cables. Design variable frequency drive system so that rear cabinet access is not required for operations, maintenance, and repair tasks. Other enclosure requirements are:

1. Treat metal surfaces and structural parts by phosphatizing prior to painting.

2. Apply a gun-metal gray undercoat to enclosures which is equal to zinc chromate.

3. Finish exterior of the enclosures in ANSI-61 gray enamel or furnish in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.

4. The doors shall have full length piano type hinges.

5. Brace each door to prevent sag when fully open.

B. Furnish each variable frequency drive system with the control switches, alarm lights and indicators as specified herein and as indicated on the Drawings. Furnish main circuit breakers with an external operating handle interlocked with the door so that the door cannot be opened unless the disconnect is in the OFF position. Power supply to the motor from both the variable frequency drive and the bypass starter shall be capable of being positively locked in the OFF position. The disconnect shall be interlocked so that equipment cannot be energized when the door is open.

C. Electrical bus, including ground bus, shall be tin-plated copper. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.

D. Equipment shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.

2.08 HARMONIC DISTORTION SUPPRESSION

A. A comprehensive pre-equipment-selection harmonic study shall be prepared by the Contractor. The results of this pre-equipment selection study shall be submitted to the Engineer as part of the submittals specified herein. Should this study indicate the need for tuned filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment, these shall be supplied at no additional cost to the Owner. Indicate the location of the harmonic suppression equipment in the submittal data. Location is subject to acceptance by the Engineer.

B. The harmonic distortion values resulting from operation of all or any variable frequency drive-driven motor-load combinations operating at full load shall be as defined in IEEE Standard 519.

1. Maximum allowable total harmonic voltage distortion (THD): 5 percent of the fundamental.

2. Maximum allowable individual frequency harmonic voltage distortion: within the limits of IEEE standard 519.

3. Maximum allowable total demand distortion (TDD): within the limits of IEEE Standard 519-1992, Table 10.3.

4. Maximum allowable individual frequency harmonic demand distortion: within the limits of IEEE Standard 519-1992, Table 10.3.

5. The harmonic distortion levels shall be specific to the "Point of Common Coupling" (PCC) as defined in IEEE Standard 519 and indicated on the Drawings.

C. System single line diagrams and field access to the plant site will be provided to the Contractor for the purpose of providing this study. Contractor shall obtain from others other information that may be necessary to perform this study. Input data and other pertinent information used in harmonic study shall be coordinated by the Contractor with the following:

1. Input data/information/results of the short circuit fault analysis specified herein.

2. Electrical system configuration and electrical equipment shop drawing submittal data including, but not being limited to new non-linear loads, new linear loads, and new capacitors.

D. Preparation of this pre-equipment selection study does not relieve the requirement for the Contractor to perform and submit the results of a second, final comprehensive study prepared by a recognized independent authority acceptable to the Owner after equipment installation.

E. In addition, the Contractor shall field measure actual harmonic distortion and verify with tests performed by an independent authority acceptable to the Owner after satisfactory full-load operation.

F. As part of the specified harmonic studies and other work for this project, identify and correct resonance conditions in the electrical distribution system at no additional cost to the Owner. Shop drawings, data, location of the respective equipment and its connection to the electrical distribution system shall be acceptable to the Engineer.

G. Reference Section 16000S, Basic Electrical Requirements for information gained from the electric utility company during the design period which could be used for the purpose of the harmonic study. Inclusion of this information, however, does not relieve the Contractor nor his suppliers of the responsibility of obtaining all the necessary information required to perform the harmonic study.

2.09 BYPASS STARTERS

A. Variable frequency drive manufacturer shall furnish and the Contractor shall install motor starters for bypass operation and associated accessories as specified herein and as indicated on the Drawings. The bypass starters shall be of motor control center construction and shall be as specified in Section 16482, Low Voltage Motor Control Center.

B. Provide bypass starters with full capacity rated contactors, each interlocked with the contactors of the variable frequency drive.

C. Where a bypass starter is to be furnished and installed in conjunction with a variable frequency drive as part of a motor control system, the variable frequency drive and the bypass starter equipment shall be designed and manufactured to allow qualified plant personnel to safely test, maintain, and work on the VFD or the bypass starter while the motor is running. That is, plant personnel should be able to safely work on the bypass starter while the load is running via the VFD and safely work on the VFD while the load is running via the bypass starter.

2.10 MISCELLANEOUS

A. Encapsulate critical components in ceramic or metal.

B. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100 percent redundant. A new and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be acceptable.

B. Circuit boards and electrical components shall meet the corrosion protection requirements specified in these Specifications. Varnished or epoxy encapsulated circuit boards and tropicalized contactors suitable for corrosive environments shall be furnished where the VFDs are not located in climate controlled areas.

2.11 ISOLATION TRANSFORMERS

A. The Contractor shall furnish and install isolation transformers as specified herein and indicated on the Drawings. Reference Section 16461 - Dry Type Distribution Transformers.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The VFD's shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. Install VFD's to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.

C. Include in the bid an allowance for factory-trained service personnel, other than sales representatives, to supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested by the Contractor and the results of these tests have been accepted by the Engineer.

3.02 PAINTING

A. All metal surfaces of the motor control equipment shall be thoroughly cleaned and given one prime coat of zinc chromate primer. All interior surfaces shall then be given one shop furnished coat of a lacquer of the nitro-cellulose enamel variety. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be as approved by the Engineer. Color chips shall be forwarded to the Engineer for color selection and approval prior to finish painting. The interior of the VFD enclosure shall be painted white.

B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

3.03 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each VFD assembly. The mat shall be long enough to cover the full length of each VFD system. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION -

SECTION 16902S

ELECTRIC CONTROLS AND RELAYS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.

B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.

C. Reference Section 16000S, Basic Electrical Requirements and Section 16195S, Electrical Identification.

1.02 CODES AND STANDARDS

A. Products specified herein shall be in conformance with or listed to the following standards as applicable:

1. NEMA 250 – Enclosures for Electrical Equipment

2. UL 508A – Standard for Industrial Control Panels

3. UL-1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

4. ANSI/ISA 12.12.01-2013 – Nonincendive Electrical Equipment for use in Class I and II, Division II Hazardous (Classified) locations.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01302S, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

B. Each submittal shall be identified by the applicable specification section.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

<u>PART 2 -- PRODUCTS</u>

2.01 CONTROL COMPONENTS

A. Manufacturers

1. Control components shall be manufactured by Eaton, The Square D Company, General Electric, Allen-Bradley, Siemens Energy and Automation, or Engineer approved equal.

B. Pilot Devices

1. General

   a. All pilot devices shall be provided with a legend plate. Legend plates shall have a white background and black lettering and indicate the function of the respective pilot device. The text shown on the Drawings or indicated in the specifications shall be used as the basis for legend plate engraving (i.e. HAND-OFF-AUTO, RUN, EMERGENCY STOP, etc).

   b. All pilot devices shall be selected and properly installed to maintain the NEMA 250 rating of the enclosure in which they are installed. All pilot devices shall be UL 508 Listed.

   c. All pilot devices shall be 30.5mm in diameter, unless otherwise indicated. 22mm devices are not acceptable.

   d. Pilot devices for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

   e. In Class 1 Division 2 hazardous locations, pilot devices shall be the hermetically-sealed type, constructed in accordance with ANSI/ISA 12.12.01.

2. Pushbuttons

   a. Pushbuttons shall be non-illuminated, black in color, and have momentary style operation unless otherwise indicated on the Drawings.

   b. Pushbuttons shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each pushbutton. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

   c. Pushbuttons shall be provided with a full guard around the perimeter of the button. Where a lockout style pushbutton is specified or indicated on the Drawings, provide a padlockable guard.

3. Selector Switches

   a. Selector switches shall be non-illuminated, black in color, and have the number of maintained positions as indicated on the Drawings and as required. Handles shall be the extended type that provide a greater surface area for operation.

   b. Selector switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each selector switch.

Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

c. Where indicated in the Drawings or Specifications, provide spring return positions.

d. Selector switches shall be provided with an indexing component that fits into the keyed portion of the cutout for the device and prevents the switch from spinning when operated.

4. Indicating Lights

a. Indicating lights shall LED type, with the proper voltage rating to suit the application, and push-to-test feature.

b. Indicating light lens colors shall be as required in equipment specifications and/or as indicated on the Drawings. If lens colors are not indicated, the following colors shall be used:

i. Red - "Run", "On", “Open”

ii. Green - "Off", “Closed”

iii. Amber - "Alarm", "Fail"

iv. White - “Control Power On”

5. Emergency Stop and Tagline Switches

a. Emergency stop switches shall be non-illuminated, red in color, with a minimum 35mm diameter mushroom head. Once activated, switch shall maintain its position and require a manual pull to release/reset.

b. Tagline switches shall have a plunger that activates upon tension from the associated safety cable. Once activated, switch shall maintain its position and require a manual release/reset.

c. Emergency stop and tagline switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

C. Relays and Timers

1. General

a. Relays and timers shall be furnished with an integral pilot light for positive indication of coil energization.

b. Relays and timers shall have tubular pin style terminals with matching 11-pin DIN rail mount socket. Spade or blade style terminals are not acceptable.

c. Relays and timers for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

2. Control and Pilot Relays

a. Miniature or “ice-cube” type relays are not acceptable.

b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.

c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have 3-pole, double-throw (3PDT) contact arrangement.

3. Time Delay Relays

a. Timers delay relays shall utilize electronic timing technology. Mechanical timing devices are not acceptable.

b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.

c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have double-pole double-throw (DPDT) contact arrangement.

d. Time delay ranges shall be as indicated on the Drawings and/or as required to suit the application. Timing range shall be adjustable from the front of the relay. On delay and off delay timer configurations shall be provided as indicated on the Drawings and/or as required to suit the application.

4. Elapsed Time Meters

a. Elapsed time meters shall be non-resettable type with no less than a 4 digit display. Coil voltage shall be as required to suit the application and/or as indicated on the Drawings.

D. Control Terminal Blocks

1. Control terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or subpanel. Terminals shall be tubular screw type with pressure plate that will accommodate wire size range of #22 - #8 AWG.

2. Control terminal blocks shall be single tier with a minimum rating of 600 volts and 20A. Separate terminal strips shall be provided for each type of control used (i.e.

120VAC vs. 24VDC). Quantity of terminals shall be provided as required to suit the application. In addition, there shall be a sufficient quantity of terminals for the termination of all spare conductors.

3. Terminals shall be marked with a permanent, continuous marking strip, with each terminal numbered. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

2.02 LOCAL CONTROL STATIONS

A. Local control stations shall be furnished and installed complete with pushbuttons, selector switches, indicating lights, and other devices as indicated on the Drawings.

B. Specific devices installed in local control stations shall be provided in accordance with the requirements specified elsewhere in this Section.

C. In non-hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Die Cast Zinc
Indoor Dry Non-process Area	NEMA 12, Die Cast Zinc
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or Thermoplastic Polyester
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

D. In hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class 1, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class 1, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel
Class 2, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class 2, Division 2, Group F	NEMA 9, Die Cast Aluminum

E. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs. Conduit hubs shall be external to the enclosure.

F. Local control stations for use in non-hazardous locations shall be UL-508 Listed. Local control stations for use in Class 1 Division 1 and Class 2 Divisions 1/2 hazardous locations shall be UL-1203 Listed. Local control stations for use in Class 1 Division 2 hazardous locations shall be in accordance with ANSI/ISA 12.12.01-2013.

G. Provide a nameplate on each local control station in accordance with Section 16195S, Electrical Identification. The name and/or number of the equipment associated with each control station shall be engraved on the nameplate, followed by the words “LOCAL CONTROL STATION”.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Local control stations shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

B. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices.

C. Pilot devices shall be properly bonded to the equipment enclosure door where they are installed. If proper bonding cannot be achieved through the locknuts that affix the device in place, a green colored bonding screw shall be provided on the pilot device. The bonding screw shall be bonded to the equipment enclosure through the use of an insulated green bonding conductor.

D. Local control station covers shall be bonded to the local control station enclosure through the use of an insulated green bonding conductor.

E. Wiring to devices at each local control station shall be provided with enough slack to permit the local control station cover to be removed and pulled at least 6 inches away from the enclosure.

F. Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors. Terminal strips, relays, timers, and similar devices shall not be installed on the side walls of panel/cabinet interiors without written permission from the Engineer.

- END OF SECTION -

SECTION 17000S

CONTROL AND INFORMATION SYSTEM
SCOPE AND GENERAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SCOPE

A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, and the Offeror, all components, system installation services, as well as all required and specified ancillary services in connection with the Instrumentation, Control and Information System. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified. The system shall include all measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, remote telemetry units, signal and data transmission systems, interconnecting wiring and such accessories as shown, specified, and/or required to provide the functions indicated. The Contractor (general contractor awarded the Expansion Project) shall oversee all installation, calibration, and testing performed by the Offeror.

B. The scope of the work to be performed under this Division includes but is not limited to the following:

1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.

2. Specifications for the sidestream deammonification system are included in Division 11S, and refer to this Division for control system software, components, and practices. Where instrumentation and control is supplied by the Offeror, it is the Offeror's responsibility to ensure that the instrumentation and control systems are supplied and installed as specified in this Division and in Division 11S. In addition to common equipment and implementation specifications, specific listings of instruments, inputs and outputs, and functional control descriptions for the instrumentation and control system subcontractor and the Offeror are included under this Division.

3. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.

4. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Division 17S.

5. Furnish and install digital control system hardware and software as specified in Division 17S.

6. Final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under Division 17S.

7. Furnish, install and terminate all special cables (instruments, telemetry, etc.). Furnish and terminate control system communication network cables.

8. Furnish and install surge protection devices for all digital equipment, local control panels, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 16S.

9. Coordinate grounding requirements with the electrical subcontractor for all digital equipment, local control panels, and instrumentation provided under this Division. Terminate grounding system cables at all equipment provided under this Division.

10. Provide system testing, calibration, training and startup services as specified herein and as required to make all systems fully operational.

C. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested and calibrated as specified under other Divisions.

B. Additional and related work performed under Division 16S includes the following:

1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for all equipment, control panels and accessories furnished under Division 17S.

2. Conduit and raceways for all instrumentation and control system signal wiring, grounding systems, special cables and communication network cables.

3. Instrumentation and control system signal wiring.

4. Install control system communication network cables.

5. Furnish and install grounding systems for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under Division 17S. Grounding systems shall be complete to the equipment provided under Division 17S, ready for termination by the instrumentation subcontractor.

6. Termination of all instrumentation and control system signal wiring at all equipment furnished under other divisions of the Specifications.

7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g. panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.

B. In order to centralize responsibility, it is required that all equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.

C. The Offeror shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Offeror shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems and shall provide for the services of a qualified installation engineer to supervise all activities required to place the completed facility in stable operation under full digital control.

D. The instrumentation and control system shall be capable of simultaneously implementing all real-time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of any system component.

E. Control system inputs and outputs are listed in the Input/Output Schedule. This information, together with the functional control descriptions, process and instrumentation diagrams, and electrical control schematics, describes the realtime- monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.

F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as fieldmounted- equipment provided by others. The Offeror shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the control and information system. The Offeror shall coordinate the completion of any required modifications with the associated supplier of the item furnished.

G. The Contractor shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.

H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the Offeror furnishing the equipment under this Division.

I. The Offeror shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

J. The Owner shall have the right of access to the Offeror's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The Offeror and his equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

K. The terms "Instrumentation", "Instrumentation and Control System", and "Instrumentation, Control and Information System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the Specifications.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water and wastewater treatment facilities. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers and/or models of major hardware or software products (PLC, HMI software, LAN, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term "completed" shall mean that a project has been brought to final completion and final payment has been made. Any instrumentation and control system subcontractor that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five calendar years shall not be acceptable.

B. Acceptable instrumentation and control system subcontractors shall be CIM Automation Systems - M.C.Dean; E-Merge Systems, Inc.; or SL Controls (Sherwood Logan).

1.05 DEFINITIONS

A. <u>Solid State</u>: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.

B. <u>Bit or Data Bit</u>: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.

C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.

E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.

F. Availability: The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

A = 100 x (MTBF/(MTBF + MTTR)) Percent

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

A = A2 + 1 (-(1-A1) x (1-A1))

where:

A1 = availability of non-redundant device or system
A2 = availability of device or system provided with an automatically switched backup device or system

G. Abbreviations: Specification abbreviations include the following:

A	-	Availability
ADC	-	Analog to Digital Converter
AI	-	Analog Input
AO	-	Analog Output
AVAIL	-	Available
BCD	-	Binary Coded Decimal
CSMA/CD	-	Carrier Sense Multiple Access/Collision Detect
CPU	-	Central Processing Unit
CRC	-	Cyclic Redundancy Check
CRT	-	Cathode Ray Tube
CS	-	Control Strategy

DAC	-	Digital to Analog Converter
DBMS	-	Data Base Management System
DI	-	Discrete Input
DMA	-	Direct Memory Access
DO	-	Discrete Output
DPDT	-	Double Pole, Double Throw
DVE	-	Digital to Video Electronics
EPROM	-	Erasable, Programmable Read Only Memory
FDM	-	Frequency Division Multiplexing
FSK	-	Frequency Shift Keyed
HMI	-	Human Machine Interface (Software)
I/O	-	Input/Output
LAN	-	Local Area Network
LDFW	-	Lead-Follow
MCC	-	Motor Control Center
MTBF	-	Mean Time Between Failures
MTTR	-	Mean Time To Repair
OS	-	Operating System
PAC	-	Programmable Automation Controller
PCB	-	Printed Circuit Board
PID	-	Proportional Integral and Derivative Control
PLC	-	Programmable Logic Controller
PROM	-	Programmable Read Only Memory
RAM	-	Random Access Memory
RDY	-	Ready
RMSS	-	Root Mean Square Summation
RNG	-	Running
ROM	-	Read Only Memory
RTU	-	Remote Telemetry Unit
SPDT	-	Single Pole, Double Throw
ST/SP	-	Start/Stop
TDM	-	Time Division Multiplexing
UPS	-	Uninterruptible Power Supply

H. To minimize the number of characters in words used in textual descriptions on CRT displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.06 ENVIRONMENTAL CONDITIONS

A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.

B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.

D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

PART 2 -- PRODUCTS

2.01 NAMEPLATES

A. All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the Engineer's approval.

B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.

C. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxybased- adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

PART 3 -- EXECUTION

3.01 SCHEDULE OF PAYMENT

A. Payment to the Offeror for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System as outlined below.

B. The following payment schedule defines project milestones that will be used for establishing maximum partial payment amounts for the Control and Information System. Payment for field instruments, field wiring, fiber optic network cable and similar items will be made in addition to the payment for the scopes of services incorporated into the schedule below.

Task Completed	**Maximum Cumulative % Request for Payment**
Mobilization	3%
Preliminary Design Review	5%
Approved Submittals	20%
Hardware Purchase (excludes field instruments)	40%
Factory Acceptance Test	60%
Loop Checkout	70%
Control System Start-up and Test	80%
Plant Start-up	90%
Final System Acceptance Test	95%
Final Acceptance	100%

C. Requests for payment for materials and equipment that are not installed on site, but are required for system construction and the factory acceptance test (e.g., digital hardware), or are properly stored as described in the General and Supplementary Conditions and herein, shall be accompanied by invoices from the original supplier to the instrumentation subcontractor substantiating the cost of the materials or equipment.

D. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance test.

3.02 CLEANING

A. The Offeror shall thoroughly clean all soiled surfaces of installed equipment and materials.

B. Upon completion of the instrumentation and control work, the Offeror shall remove all surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.03 FINAL ACCEPTANCE

A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:

1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.

2. Completion of the Availability Demonstration.

3. Completion of all specified control system training requirements.

4. Completion of all punch-list items that are significant in the opinion of the Engineer.

5. Delivery of fully documented application and process control software source code.

B. Final acceptance of the System shall mark the beginning of the extended warranty period.

- END OF SECTION -

SECTION 17031S

CONTROL AND INFORMATION SYSTEM SUBMITTALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall submit for review complete Shop Drawings for all equipment in accordance with the General Conditions and Division 1S of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01302S – Submittals

B. Section 17000S – Control and Information System Scope and General Requirements

1.03 PERSONNEL SUBMITTALS

A. Personnel submittals shall include certification of factory training of instrumentation technicians provided by the instrumentation subcontractor.

1.03 DIGITAL HARDWARE SUBMITTALS

A. Submit system block diagram(s) showing:

1. All equipment to be provided.

2. All interconnecting cable.

3. Equipment names, manufacturer, and model numbers.

4. Equipment locations.

B. Submit information for all digital equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.

2. Catalog cuts, including complete part number breakdown information.

3. Complete technical, material and environmental specifications.

4. Assembly drawings.

5. Mounting requirements.

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6. Color samples.

7. Nameplates.

8. Environmental requirements during storage and operation.

1.04 SOFTWARE SUBMITTALS

A. Software submittals shall include the following as a minimum:

1. Bill of materials with software names, vendors, and complete listings of included software modules.

2. Standard manufacturer's literature describing the products.

3. Description of function of software in Control and Information System.

4. Limitations or constraints of software.

5. Minimum system (processor and memory) requirements.

6. Operation and maintenance requirements.

7. Asset List of tagged items.

B. Submit information on the following software:

1. Third-party software, including:

   a. Operating system.

   b. Operator workstation (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).

   c. Office-type products, such as spreadsheets, word processors, etc.

   d. Database management software.

   e. Communication software, including all applicable local and wide area network software.

   f. Programmable controller programming software (where applicable).

2. Software configuration, including:

   a. Graphic display organization.

   b. Database configuration for operator workstations and database management system.

c. Trends.

d. System security.

e. Formats for all reports, including all required calculations.

f. Intercommunications between software products required to implement system functions.

g. Equipment backup configuration and requirements.

C. Control Strategies

1. Provide control strategy documentation that includes control strategy diagrams (block oriented logic and ladder logic diagrams, as appropriate) to describe the control of all processes. The written description shall follow the format of the functional control descriptions contained herein. The control strategy submittals shall contain the following as a minimum:

a. An overall description of the program structure and how it will meet the specified control requirements.

b. A listing of the program.

c. Extensive comments in the listings to describe program steps.

d. Equation and ladder program derivations for all specified control routines.

e. Resource (processor and memory) requirements.

f. A listing of inputs and outputs to the control strategy.

D. Application Software

1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include any add-in custom software.

E. Graphic Displays

1. Submit all 2D and 3D graphic displays required to perform the control and operator interface functions specified herein.

2. Submit the complete set of graphic displays in ICONICs file format and pdf for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.

3. Where a large number of graphic displays are required, submit an initial set of example displays for review before the complete set of displays is submitted. This initial set shall include examples of all basic graphic display design features and parameters, and is intended to allow the Offeror to obtain preliminary approval of these features and parameters prior to beginning main graphic display production.

4. The Offeror shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer and the Owner. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.

5. Two of the required submittals in each revision cycle shall be ICONICs file format and PDF.

6. Displays shall be printouts of actual process graphics implemented in the system.

1.05 CONTROL PANEL SUBMITTALS

A. Submittals shall be provided as AutoCAD file format and PDF for all control panels, and shall include:

1. Exterior panel drawings with front and side views, to scale.

2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.

3. Panel area reserved for cable access and conduit entry.

4. Location plans showing each panel in its assigned location.

B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.

2. Catalog cuts, including complete part number breakdown information.

3. Complete technical, material and environmental specifications.

4. Assembly drawings.

5. Mounting requirements.

6. Color samples.

7. Nameplates.

8. Environmental requirements during storage and operation.

C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

1.06 INSTRUMENT SUBMITTALS

A. Submit information on all field instruments, including but not limited to the following:

1. Product (item) name and tag number used herein and on the Contract Drawings.

2. Catalog cuts, including complete part number breakdown information.

3. Manufacturer's complete model number.

4. Location of the device.

5. Input output- characteristics.

6. Range, size, and graduations.

7. Physical size with dimensions, NEMA enclosure classification and mounting details.

8. Materials of construction of all enclosures, wetted parts and major components.

9. Instrument or control device sizing calculations where applicable.

10. Certified calibration data on all flow metering devices.

11. Environmental requirements during storage and operation.

12. Associated surge protection devices.

1.07 WIRING AND LOOP DIAGRAMS

A. Submit interconnection wiring and loop diagrams for all panels and signals in the Control and Information System.

B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.

C. Loop drawings shall conform to the latest version of ISA Standards and Recommended Practices for Instrumentation and Control. Loop Drawings shall conform to ISA S5.4, Figures 1-3, Minimum Required.

D. Loop drawings shall not be required as a separate document provided that the interconnecting wiring diagrams required in Paragraph B., above, contain all information required by ISA 5.4.

1.08 PROCESS AND INSTRUMENTATION DIAGRAMS

A. Submit Process and Instrumentation Diagrams showing all instrumentation and control equipment, and all monitoring and control functions, for the entire Control and Information System as specified herein.

B. Process and Instrumentation Diagrams shall conform to ISA S5.1 and S5.3, and all applicable ISA standards for symbology, nomenclature, and layout.

1.09 OPERATION AND MAINTENANCE MANUALS

A. The Offeror shall deliver equipment operation and maintenance manuals in compliance with Section 01302S - Submittals. Operation and maintenance (O&M) manuals shall consist of two basic parts:

1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.

2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.

B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.

1. A comprehensive index.

2. A functional description of the entire system, with references to drawings and instructions.

3. A <u>complete</u> "asbuilt-" set of <u>all</u> approved shop drawings, which shall reflect all work required to achieve final system acceptance.

4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

5. Full specifications on each item.

6. Detailed service, maintenance, and operation instructions for each item supplied.

7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

9. References to manufacturers' standard literature where applicable.

10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

D. The operating instructions shall clearly describe the step-by-step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.

F. The hardware maintenance documentation shall include, as a minimum, the following information:

1. Operation Information – This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

2. Preventive Maintenance Instructions – These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, calibration, and the adjustments necessary for periodic preventive maintenance of the System.

3. Corrective Maintenance Instructions – These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.

4. Parts Information – This information shall include the identification of each replaceable or field repairable component. All parts shall be identified on a list in

a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross references between equipment numbers and manufacturer's part numbers shall be provided.

G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:

1. A program abstract that includes:

a. Program Name - The symbolic alphanumeric program name.

b. Program Title - English text identification

c. Program Synopsis A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by nonsoftware- oriented readers.

2. A program description that shall include, but not be limited to, the following:

a. Applicable Documents - List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.

b. Input/Output- - Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.

c. Processing - This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.

d. System Configuration – Describe in detail the system configuration or status required for program implementation, if appropriate.

e. Limitations and Constraints – Summarize all known or anticipated limitations of the program, if appropriate.

f. Storage - Define program storage requirements in terms of disk or RAM memory allocation.

g. Verification - Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.

h. Diagnostics - Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.

i. Malfunction Procedures – Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.

j. Glossary of Terms – Provide a list and definition of all terminology

k. Tag Database – Provide a list of all tags

1.10 FINAL SYSTEM DOCUMENTATION

A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents as specified in Section 17070S. As a minimum, final documentation shall contain all information originally part of the control system submittals.

B. If any documentation or other technical information submitted is considered proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary will be used only for the construction, operation, or maintenance of the System and, to the extent permitted by law, will not be published or otherwise disclosed.

C. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected so as to describe final "as built-" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.

D. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as built- software configurations.

E. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

F. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.

G. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.

H. The Owner recognizes the fact that not all possible problems related to real-time events, software interlocks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the Offeror shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

1.11 PROGRAMS AND SOURCE LISTINGS

A. Provide one copy of all standard, of-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer, excluding ICONICS and Rockwell Automation.

B. Provide one copy of source listings on optical media for all custom software written specifically for this facility, all database files configured for this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

1.12 SUBMITTAL/DOCUMENTATION FORMAT

A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.

B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in Searchable Adobe Portable Document Format (.pdf).

1.13 ELECTRONIC O&M MANUALS

A. Subject to acceptance by the Owner and Engineer, the O&M information may be submitted in part or in whole in an electronic format on optical media.

B. Electronic O&M manuals shall contain information in standard formats (Searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible through the use of standard, “off-the-shelf” software such as an Internet browser.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17040S

CONTROL AND INFORMATION SYSTEM TRAINING REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. To familiarize the Owner's personnel with the process control system and field instrumentation, training shall be provided as detailed hereunder.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

1.03 SUBMITTALS

A. A minimum of 60 days prior to beginning training, submit a detailed training plan describing the following:

1. A listing of all courses to be conducted.

2. Course content.

3. Applicability of each course to management, operations, maintenance, laboratory, etc., personnel.

4. Course schedules.

5. Qualifications and experience of individual(s) providing training.

B. A minimum of 14 days prior to beginning each training course, submit documentation for use by the Owner's personnel during training. The training documentation shall be specific to the particular course, and shall include the following:

1. A listing of all subjects to be covered.

2. Course schedule.

3. Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.

1.04 GENERAL REQUIREMENTS

A. All costs of providing the training courses shall be borne by the Contractor.

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B. As used herein, the term "day" shall mean an eight-hour day, and the term "week" shall mean a five day, 40-hour week.

C. Training courses, especially those for operator training, may be required to be scheduled during non-standard business hours (i.e., not between the hours of 8:00 am and 5:00 pm) to accommodate the working schedule of the Owner's personnel. No additional compensation will be awarded to the Offeror for training at non-standard hours.

D. All training courses shall complement the experience and skill levels of the Owner's personnel.

E. Training courses shall be structured in order of increasing capability or security levels. The purpose of this requirement is to allow personnel with lesser training requirements or security password levels to drop out of the training at certain times while the training continues for personnel with greater requirements or higher security levels.

F. All training courses shall include lecture as well as "hands on" experience for each of the attending personnel. The Offeror shall provide sufficient equipment for this to be accomplished. For example, training in which the instructor uses the computer and the Owner's personnel passively observe as the instructor demonstrates system functions <u>shall not be acceptable</u>.

G. Unless otherwise specified, all training courses shall be conducted in the Owner's facilities.

H. All training shall be completed prior to system acceptance.

I. Standard manufacturer training courses are acceptable pending approval by the Engineer and Owner.

1.05 SYSTEM SUPERVISOR/ENGINEER TRAINING

A. System supervisor/engineer training shall be performed a minimum of 30 days prior to system startup.

B. Training shall be provided in the following subjects:

1. System overview and capabilities.

2. Database configuration.

3. Graphic display configuration, including linking of data to displays.

4. Historical data configuration (collection, manipulation, and display).

5. Real-time and historical trending.

6. Report configuration, generation, printing, and customization.

7. Alarm configuration and management.

8. System security.

9. I/O driver use and configuration.

10. System backup and recovery.

11. DDE linking, where applicable.

12. System command language.

13. Troubleshooting.

14. System optimization.

15. System startup and shutdown procedures.

16. LAN and WAN communications, as appropriate.

C. The course shall be structured as follows:

1. Fundamentals One four day course (minimum) shall be provided for up to eight persons which shall serve as a digital control system familiarization course for project management personnel, engineers, and key operating/maintenance personnel. This course shall be a prerequisite for the advanced course described below in Item 2.

2. Advanced One four day (minimum) digital system configuration and operating course shall be provided for up to four persons. The level of training shall be sufficient to familiarize the Owner's personnel with the configuration and application of all system programs. All essential system operating procedures shall be described as required to enable the Owner's personnel to operate the system via the various workstations and local control panels.

3. Historical – One two-day course to instruct a minimum of four persons in the use and configuration of the historical data archival system. Training shall include creation, viewing, and printing of trends, charts, and reports. Training shall include all database maintenance and archival functions necessary to maintain the facility's data on both short and long term basis, including periodic archival to optical media.

1.06 OPERATOR TRAINING

A. Two two-week courses comprised of daily half-day (four-hour) sessions for up to ten persons each shall be conducted to provide instruction in the use of the Control and Information System to monitor and control the facility.

B. Operator training shall include familiarization training covering the Control and Information System. Operators shall be instructed in the names, locations, functions, and basic operation of all items of digital equipment and associated software.

C. Operator training shall cover process and equipment operation both individually and collectively as an operating system. Normal as well as abnormal operating conditions shall be covered, including the response to failure occurrences and system alarms. All operator/system interactions shall be described.

D. Operators shall be trained to instruct other operators and shall be provided with all course materials.

1.07 MAINTENANCE TRAINING

A. A three-day course shall be conducted for at least six persons prior to the startup of digital equipment at the Owner's plant. Instruction shall be provided in the following:

1. Operating all digital equipment, including system startup and shutdown procedures.

2. The use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to the circuit board or module level and to implement repairs by replacing failed circuit boards or modules.

3. Calibration and routine maintenance procedures for all analog and digital equipment.

B. Step by step written procedures shall be provided for all preventive maintenance tasks and for identifying hardware faults to the circuit board or module level for all items of digital equipment.

C. All digital equipment preventive and corrective maintenance training activities shall be limited to the use of commercially available off-the-shelf test equipment and to the use of diagnostic routines and hardware items which are the same as those to be provided as part of the system.

1.08 INSTRUMENT TRAINING

A. A three-day course shall be provided at the Owner's facilities no more than three months prior to system start-up to instruct a minimum of five persons each in the calibration and preventive maintenance of the field instruments provided under this Contract.

1.09 PLC TRAINING

A. Up to three-day manufacturer training course shall be provided to cover PLC maintenance and troubleshooting of the automation hardware. This training shall be provided by the PLC manufacturer.

B. Up to three-days course of specific training shall be provided by the Offeror (sidestream deammonification system manufacturer) in the use of all control strategies provided under this Division.

1.10 GENERAL REFRESHER TRAINING

A. A one-week general refresher training course shall be provided for up to ten persons 3-6 months after final system acceptance. Instruction shall be given in all aspects of the complete instrumentation and control system. Instructor(s) shall be capable of answering questions related to all aspects and details of the complete system.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17050S

TOOLS, SUPPLIES AND SPARE PARTS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall provide tools, supplies, and spare parts as specified herein for the operation and maintenance of the Control and Information System.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01302S – Submittals

B. Section 17000S – Control and Information System Scope and General Requirements

PART 2 -- PRODUCTS

2.01 TOOLS

A. Provide special tools, other than those normally found in an electronic technician's tool box, required to test, diagnose, calibrate, install, wire, connect, disconnect, assemble and disassemble any digital equipment, instrument, panel, rack, cabinet or console mounted equipment for service and maintenance. This shall include, but not be limited to, the following: connector pin insertion and removal tools, wire crimping tools, special wrenches, special instrument calibrators, indicator lamp insertion and removal tools, etc.

B. Provide tools and test equipment together with items such as instruction manuals, carrying/storage cases, unit battery charger where applicable, special tools, calibration fixtures, cord extenders, patch cords and test leads, which are not specified but are necessary for checking field operation of equipment supplied under this Division.

C. One (1) Portable graphical multimeter with rechargeable battery, test leads, industrial lead set, and carrying case, Fluke Model 289, or equal.

D. Furnish one portable 4-20 mA, 24 VDC analog loop signal generator for calibration and testing of analog signal loops. Generator shall be furnished with rechargeable battery pack, test leads, spare battery pack, charger, carrying case and accessories. Signal generator shall be Fluke 787 ProcessMeter, or equal.

E. If instruments are being provided with HART protocol enabled, furnish one portable HART Communicator with batteries, test leads, and case, Fluke Model 709H.

F. Furnish one portable calibrator capable of measuring DC volts, mV, mA, ohms, frequency, T/C, peak detect and trip detect on its input and simultaneously generate on its output all of the preceding signals plus two-wire simulation, ramp functions, up/down stepping and 10 point programmability. The calibrator shall be furnished complete with 24 VDC integral battery pack, spare battery pack, test leads, external charger, fuse

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pack, carrying case and appurtenances. It shall be possible to store and use automatic instrument calibration procedures that are downloaded from Windows-based instrument management software. Calibrator shall be Fluke 789 ProcessMeter, or equal.

G. A complete computer technician kit in an injection molded or high density polyethylene case. The kit shall be Model JTK-49 Workstation Kit by Stanley Supply Services of Phoenix, AZ, or a computer technician kit of equivalent equipment and value.

2.02 SUPPLIES

A. The Offeror shall provide supplies as specifically required in other Sections of Division 17S.

2.03 SPARE PARTS

A. Provide spare parts for items of control and instrumentation equipment as recommended by the manufacturer and in accordance with the Contract Documents.

B. Furnish all spares in moisture-proof boxes designed to provide ample protection for their contents. Label all boxes to clearly identify contents and purpose.

C. The Offeror shall replace all spare parts consumed during installation, testing, start-up, the system availability demonstration, and the guarantee period.

D. Refer to individual digital hardware and instrument sections for additional requirements specific to those devices.

<u>PART 3 -- EXECUTION</u>

(NOT USED)

- END OF SECTION -

SECTION 17060S

SIGNAL COORDINATION REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall conform to the signal coordination requirements specified herein.

B. The Offeror shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, and the electrical subcontractor.

C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLC's and Control System PLC's.

D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLC's, the Control System, etc.

1.02 ANALOG SIGNAL TRANSMISSION

A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 volts D.C.

B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.

C. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.

D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.

E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliampere signal.

F. The Offeror shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.

G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.

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H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

1.03 DISCRETE INPUTS

A. All discrete inputs to equipment and Control and Information System PLC's, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLC's, unless specified otherwise.

B. Sensing power (wetting voltage) supplied by the PLC shall be 120 VAC.

1.04 DISCRETE OUTPUTS

A. All discrete outputs from local control panels and Control and Information System PLC's to field devices, starters, panels, etc., shall be 120 VAC powered (sourced) from PLC's.

B. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC's to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.

C. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

1.05 OTHER DISCRETE SIGNALS

A. Discrete signals between starters, panels, etc. shall be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.

B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.

C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.

D. The above requirements shall apply to all starters and panels, regardless of supplier.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

A. All control wiring must use appropriate sized wire ferrules with termination connections.

- END OF SECTION -

SECTION 17070S

CONTROL AND INFORMATION SYSTEM TESTING - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall test the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17071S – Factory Acceptance Test

C. Section 17072S – Field Testing

D. Section 17073S – Final Acceptance Test

1.03 SUBMITTALS

A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:

1. A schedule of all testing to be conducted.

2. A brief description of the testing to be performed

3. Test objectives.

4. Testing criteria per the Specifications.

5. Check lists and procedures for performing each of the specified tests.

6. Sample test result documentation.

7. Requirements for other parties.

1.04 GENERAL REQUIREMENTS

A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.

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B. The Offeror shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.

C. The Offeror (or designee) shall maintain master logbooks for <u>each</u> phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Offeror signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.

D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.

E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17071S

FACTORY ACCEPTANCE TEST

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall perform a Factory Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

B. Loudoun Water or an authorized representative of the Loudoun Water and the Engineer shall have the option to witness the Factory Acceptance Test performed by the Offeror.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17070S – Control and Information System Testing, General

C. Section 17072S – Field Testing

D. Section 17073S – Final Acceptance Test

1.03 FACTORY ACCEPTANCE TEST

A. The Control and Information System equipment shall not be shipped until the Contractor, Owner receives notice of acceptability of the factory tests.

B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be approved in writing by the Engineer.

C. Each subsystem shall be fully factory tested for function and operation. As a minimum, all tests shall conform to "Hardware Testing of Digital Process Computers", recommended practice RP55.1. International Society of Automation.

D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.

E. All hardware and software required to perform the specified testing shall be furnished by the Offeror at no additional cost to Loudoun Water.

F. The Offeror shall perform a 100-hour full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract Documents. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.

G. The factory testing shall demonstrate all aspects of system sizing and timing including:

1. Monitoring and control scan times at the PLC level.

2. Response times at the operator workstation level.

H. The overall system as well as individual component hardware shall be tested under conditions of power failure to ensure proper response as specified herein.

I. Operator Workstation Operation – This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:

1. Demonstrate proper operation, under both normal and abnormal conditions of the operator workstation application software. This shall include demonstration of system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.

2. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.

3. Demonstrate the configuration of the system to verify conformance with the Contract Documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.

4. The system shall be operated with data input/output with the PLC's and associated panels to prove operation of all workstation functions.

5. The testing in Items 2 and 3 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously).

J. PLC Operation – All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLC's. This shall include the following:

1. Online and offline diagnostics.

2. For redundant units, failover operation and reconfiguration.

3. System initialization and restart.

4. Network communications, including fieldbus communications where required.

5. Non-volatility of memory.

6. Operation of all control logic shall be demonstrated as described herein.

K. Process I/O Simulation - Process input/output simulation for PLC's shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process I/O systems such as plugin circuit cards or I/O test modules may be utilized subject to approval by the Engineer to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:

1. To provide a means of communications checkout from the operator workstations through the various levels of software in the PLC's and to the process, i.e., the simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.

2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.

3. To provide data for use at all levels of the control system at the time of system integration.

L. Control Strategy Testing – Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -

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SECTION 17072S

FIELD TESTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17070S – Control and Information System Testing, General

C. Section 17071S – Factory Acceptance Test

D. Section 17073S – Final Acceptance Test

1.03 GENERAL REQUIREMENTS

A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:

1. Phase 1 – Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in Sections 17600S, 17700S, and 17800S.

2. Phase 2 – Each final control element shall be individually tested as specified hereinafter.

3. Phase 3 – Each control loop shall be tested as specified hereinafter.

4. Phase 4 – Each control strategy shall be tested under automatic digital control as specified hereinafter.

5. Phase 5 – The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.

B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.

C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

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1.04 OFFEROR'S RESPONSIBILITIES

A. The Offeror shall submit all test plans for approval prior to commencing any testing activities.

B. The Offeror shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Offeror (or designee) and the Engineer upon satisfactory completion.

C. The Offeror shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.

D. The Offeror shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.

E. The Offeror shall ensure that the HVAC subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

1.05 FINAL CONTROL ELEMENT TESTING

A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.

B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD's, that require turndown limits shall be initially set during this test.

C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

1.06 LOOP CHECKOUT

A. The Offeror shall verify all wiring and reverify with the Owner/Engineer/Integrator.
B. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.

C. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.

D. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.

E. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.

F. Each loop tested shall be witnessed, dated and signed off by both the Offeror (or designee) and the Engineer upon satisfactory completion.

1.07 CONTROL SYSTEM STARTUP AND TESTING

A. Startup and testing of PLC systems shall be completed prior to SCADA startup and testing.

B. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.

C. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.

D. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.

E. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.

F. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.

G. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.

H. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.

I. Each loop and control strategy test shall be witnessed and signed off by both the Offeror (or designee) and the Engineer upon satisfactory completion.

1.08 FACILITY STARTUP COORDINATION

A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.

B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.

C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.

D. At least one qualified control systems technician shall be provided for control system startup and test activities (at least two when loop checkout is being performed).

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17073S

FINAL ACCEPTANCE TEST

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall perform the Final Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17070S – Control and Information System Testing, General

C. Section 17071S – Factory Acceptance Test

D. Section 17072S – Field Testing

1.03 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE

A. Upon completion of all control system startup activities and prior to final system acceptance, the Offeror shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment failover, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. Loudoun Water shall be given two (2) weeks notice of the starting date of the 30-day availability test.

B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.

1. Downtime of any network-connected device that is automatically backed-up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.

2. Downtime of a PLC that is not automatically backed-up shall be considered a system failure if the downtime of the failed controller exceeds one (1) hour.

3. Downtime of a portion of the system resulting from failure of any field sensor shall not be considered a system failure provided that the system operates as specified under this condition.

4. Downtime of the following devices shall not be considered a system failure provided the failed device is repaired within the specified time:

a. Hard disc (one day)

b. Workstations (one day)

c. Communication interfaces (eight hours)

d. Printer (three days)

e. Process control system networks (eight hours)

f. Off-line (optical, etc.) storage units (one day)

g. UPS unit (one day)

5. Total shutdown of a single PLC resulting from a software fault shall be considered a system failure.

6. An erroneous command to the process that can be specifically related to a software fault shall be considered as one (1) hour of downtime.

7. The inoperability of any subsystem resulting from a software fault shall be considered a system failure.

8. The failure of the same component more than one time during the 30-day test shall be considered a system failure.

C. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored. The system shall be demonstrated for the full 30-day period following the restart.

D. The Offeror shall submit an availability demonstration report that shall state that all system availability requirements have been met.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

- END OF SECTION -

SECTION 17080S

QUALITY ASSURANCE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. It is the intent of these Specifications and Drawings to secure high quality in all materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Offeror shall provide equipment and services to meet this intent.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. All work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State, local and other applicable codes.

1.03 QUALITY ASSURANCE - GENERAL

A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.

B. For uniformity, only one manufacturer will be accepted for each type of product.

C. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.

D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble-free service.

E. Electronic components shall be de-rated to assure dependability and long-term stability.

F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.

G. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers.

H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

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1.05 OPTIONAL EQUIPMENT

A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Offeror shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

1.06 GUARANTEE

A. The Offeror shall install, maintain and guarantee the Instrumentation, Control and Information System as specified under the General Conditions and Division 1S of the Specifications. Maintenance personnel provided by the Offeror shall instruct the Owner's personnel in the operation, adjustment, calibration and repair of the equipment being serviced. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed and list materials used. A copy of all service reports shall be delivered to the Owner on the day the work is performed.

B. The Offeror shall provide the services of factory-trained service technician(s) at least twice during the guarantee period, for the purpose of performing preventive hardware maintenance.

C. Corrective hardware and software maintenance during the guarantee period shall be performed in accordance with the requirements of Division 1S and, in addition, shall meet the following requirements:

1. Corrective hardware maintenance shall be performed by factory-trained service technician(s) specifically trained to service the digital equipment provided. Technicians possessing suitable training and experience shall be provided to perform corrective maintenance on all other equipment. The hardware service technician(s) shall be available on-site within 24 working hours after notification by the Owner.

2. Corrective software maintenance shall be performed for software provided by the Offeror and incorporated into the system prior to the completion of system commissioning. Software service programmer(s) shall be available for consultation within four business hours and, if required, on-site within 16 business hours after notification by the Owner. Corrective software maintenance shall include the supply, installation and startup of all application software upgrades released during the guarantee period.

3. Corrective hardware and software maintenance performed during the guarantee period shall be performed at no cost to the Owner.

4. As used herein, the term "working hours" shall be defined as those of the treatment facility (seven days per week, 24 hours per day). The term "business hours" shall be defined as the hours between 8:00 a.m. and 5:00 p.m., local time, Monday through Friday; excluding holidays.

5. The guarantee period shall commence upon final acceptance of the completed treatment facility in accordance with the provisions of the Contract Documents.

D. The Offeror shall submit to the Owner a proposed maintenance agreement incorporating the following features:

1. Extension of preventive hardware maintenance services as described above for a period of up to five years from the expiration of the warranty period.

2. Provisions for corrective hardware and/or software maintenance work on a will-call basis for a period of up to five years from the expiration of the warranty period. Corrective maintenance work shall be performed by properly trained personnel as described above.

E. The proposed agreement shall include provisions for payment based upon an annual fee for preventive maintenance and cost plus expenses for corrective maintenance work. The portion dealing with corrective maintenance shall be written to include corrective maintenance caused by actions of the Owner during the warranty period and shall contain clauses for re-negotiation of contract prices based upon changes in recognized economic indicators published by the United States Department of Commerce.

1.07 SHIPPING, HANDLING, AND STORAGE

A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract Documents, air conditioning/heating shall be provided for storage of all field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

1.08 FABRICATION

A. Fabrication of all equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. The Offeror shall provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.

C. Equipment approval at the factory only allows the equipment to be shipped to the project site. The Offeror shall provide for the proper storage, installation and satisfactory start-up and operation of the equipment to the satisfaction of the equipment manufacturer, Contractor, and the Engineer.

1.09 INSTALLATION

A. All instrumentation and control system installation work, whether new construction or modifications to existing equipment/panels/structures, shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The Contractor shall assign a competent representative who shall provide full time coordination and supervision of all on-site instrumentation and control system construction work from commencement of construction through completion and final acceptance.

C. All labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.

D. All equipment and materials shall fit properly in their installations. Any required work to correct improperly fit installations shall be performed at no additional expense to the Owner.

E. All work shall be performed in a neat and workmanlike manner. All hardware and instrumentation shall be installed in accordance with requirements specified herein, in accordance with industry best practices, in accordance with manufacturers' recommendations, and in a manner suitable for ease of operation, inspection, and maintenance. All wiring shall be neatly bundled, run in wireway, and terminated. Wire ferrules shall be used. Conduit shall be sized such that there is sufficient space to install 20% more wiring in the future. All spare wiring shall be properly terminated at the terminal block with control panels, neatly coiled and clearly labeled at both ends for future use by the Owner. Any work not meeting these requirements shall be corrected at no expense to the Owner.

F. Sufficient common-mode and differential-mode noise rejection shall be provided to insure operation of the plant process control system to meet all specification requirements. General practice shall include:

1. Maintaining crossings between noisy wires and signal wires at right angles.

2. Maintaining separation between noisy wires and signal wires as wide as practical.

3. Grounding all signals, shields and power supplies at the process control unit or local control panel.

4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.

5. Eliminating cable splices. All splices in instrumentation and control system signal and network cables shall be approved in advance by the Engineer.

6. Providing a floating output for transmitters that have their own power sources.

G. DC and AC power grounding shall be performed in accordance with the digital hardware manufacturer's recommendations as well as all applicable code requirements.

H. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.

I. Power wires shall be separated from parallel-running signal wires by the following minimum spacing:

CIRCUIT VOLTAGE (VAC)	MINIMUM SPACING (IN.)
120	12
240	18
480	18
2000 and above	24

J. The Offeror shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.

K. Following acceptance of the factory tests by the Engineer, and in accordance with the construction schedule, the Offeror shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical work has been completed in the equipment rooms, MCC's, control rooms and all structural and/or mechanical work has been completed within 50 feet of equipment locations.

L. Upon completion of the above construction work, the Offeror shall request an inspection of the above-named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17100S

CONTROL AND INFORMATION SYSTEM HARDWARE, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The process control system is physically and functionally distributed between PLC equipped control panels, motor control panels, field panels, operator workstations and appurtenances.

B. Although manual control facilities shall be provided adjacent to each final control element or in local control panels, such facilities are for testing, maintenance and local monitoring purposes only and shall not be regarded as backup to the PLC-based control system.

C. PLCs may be categorized as either "process PLCs" that are provided by the Offeror or "equipment control PLCs" provided by equipment manufacturers for the operation of their equipment (blowers, centrifuges, chemical systems, filters, etc.). Unless otherwise specified, all PLCs provided under this Contract shall conform to the requirements specified in this Division.

D. Major plant control system digital equipment items are described in the Specifications and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17120S – Programmable Logic Controllers

B. Section 17140 – Operator Workstations

C. Section 17180S – Process Control System Networks

1.03 DIGITAL HARDWARE CONFIGURATIONS

A. The digital hardware configuration shown on the Control System Architecture Drawing depicts overall system configuration requirements. System design shall be based upon this concept and shall provide an overall digital system availability of 99.99 percent under the conditions specified in Section 17073S. Unless otherwise specified, designs that vary from this concept will be rejected.

B. All discrete and analog data acquisition, pre-processing, storage, alarm, and process control functions shall be performed at the PLC level. Run time and flow accumulations shall be performed at the PLC level. Except for minimal calculations related to report-specific functions such as minimum, maximum, average, etc., operator workstations shall not be used to perform calculation for the process control system. Operator workstations shall be fully independent devices, individually connected to the plant control system networks.

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C. No other exceptions will be considered.

PART 2 -- PRODUCTS

2.01 GENERAL SYSTEM HARDWARE REQUIREMENTS

A. Unless otherwise specified, all hardware shall be rated for industrial use, resistant to shock, vibration, electromagnetic interference, static discharge, and suitable for the environmental conditions described elsewhere in this Division. Commercial or office grade equipment shall not be accepted.

B. Unless otherwise specified, modular construction shall be employed to simplify maintenance and to provide for future hardware expansion. Plug-in, modular PCB's or modules shall be employed for easy removal to permit exposure of circuit wiring, components and test points. Extender boards shall be provided if necessary to permit PCB's to be completely exposed for testing purposes.

C. Keying schemes shall be used to prevent PCB misplacement.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature.

2.02 DIGITAL SYSTEM FAILURE DETECTION AND FAIL-OVER REQUIREMENTS

A. No degradation in control system performance shall occur when the system is operating in a partial failure or an equipment fail-over mode. Likewise, no degradation of system performance shall occur while a backed up system component is undergoing preventive or corrective maintenance.

B. All devices connected to the plant control system network shall be self-checking and shall report their operational status to the operator workstations as either "normal" or "failed". A graphic display based on the system architecture drawing shall be furnished with the control and information system showing this information along with current communication status of each device.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17000S, Part 3.

- END OF SECTION -

SECTION 17120S

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Offeror shall provide all programmable logic controllers, with all spare parts, accessories, and appurtenances.

B. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation all programmable logic controllers, with all spare parts, accessories, and appurtenances as herein specified.

C. At a minimum, the deammonification control system shall be provided with redundant processors for each PLC, remote I/O chassis for each deammonification reactor, and all components described below.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17060S – Signal Coordination Requirements

C. Section 17100S – Control and Information System Hardware - General

D. Section 17125S – Operator Interface Units

E. Section 17180S – Process Control System Networks

F. Section 17190S – Uninterruptible Power Systems

G. Section 17500S – Enclosures, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050S - Tools, Supplies, and Spare Parts. In addition, the following specific spare parts items shall be provided:

1. One of each type and size of module for PLC equipment furnished under this Contract.

2. One of each type and size of PLC and equipment power supply furnished under this Contract.

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PART 2 -- PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS - GENERAL

A. The Offeror shall furnish programmable controllers (PLC's) as specified herein. PLC's shall be provided complete with backplane, power supply, I/O cards, special function cards, instructions, memory, input/output capacity, and appurtenances to provide all features and functions as described herein. No substitutions will be permitted.

B. Provide programmable logic controller (PLC) system and all necessary components. Provide installed redundant PLC processor and all necessary appurtenances to provide said redundancy. Redundant I/O is not required.

C. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.

D. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.

E. Where applicable, the minimum PLC backplane size shall be 7 slots, not including power supply slots.

F. System configuration shall be as shown on the Control System Architecture Drawing. PLC types shall be designated on the Control System Architecture Drawing and correspond to the specifications herein. Only a single type of processor shall be supplied for all PLCs of a designated type. **Memory and processor shall be adequate for all control functions specified.** PLCs shall be Allen-Bradley ControlLogix with L72 processor:

2.02 PROCESSORS

A. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Nonvolatile memory in the form of a manufacturer supplied industrial CompactFlash card or equivalent technology shall be required to maintain the entire current program and firmware of the controller in the event of power loss. The program shall be updated onto the flash memory each time a program change such as an online edit or tag value is changed. When nonvolatile memory (flash memory) is not available for certain controller models as offered by the PLC manufacturer, lithium batteries shall be used to maintain process RAM memory for at least one year in the event of power loss. The lithium battery unit shall be an externally mounted battery assembly with the highest available capacity. The PLC shall send an alarm to the plant control system if battery level is low.

B. Processors shall receive an external time sync from a server located on the Owner's facility.

C. The instruction set for the PLC shall conform to the requirements of IEC 61131-3. Each PLC shall have the capability to run all five of the standard IEC 61131-3 languages simultaneously. These five languages shall be:

1. Ladder Diagram
2. Structured Text
3. Function Block Diagram

D. **Additional co-processors or modules may be necessary and shall be furnished as required to meet the functions specified herein and in Section 17950S – Functional Control Descriptions (as submitted by Offeror).**

E. PLC processors shall be provided with substantial user program, data and logic memory to allow for future expansion of the overall system. The total memory used on each processor shall be less than 60% of available memory at project completion.

2.03 COMMUNICATIONS

A. PLC communications shall be provided as specified in Section 17180S – Process Control System Networks and as described below.

B. A minimum of two Ethernet/IP communication modules shall be provided for each PLC installation. One module shall be used for plant control system network communication and the other shall be used for power monitoring device network communication.

C. Redundant Ethernet/IP with embedded switch communication modules shall be provided as required for each PLC to enable the processor to communicate with locally mounted remote input/output modules.

D. A minimum of one Ethernet/IP with embedded switch communication module shall be provided for each RIO subsystem.

E. Topology shall be device level ring using Ethernet/IP.

F. In addition, communication ports shall be provided for any other devices required (i.e., operator interface unit) plus an additional communication port for connection to a notebook computer.

G. The PLC shall be able to support various types of fieldbus communication systems for data links to field instruments (where specified) in addition to connected equipment such as power monitors, VFDs, motor protection monitors, etc. As a minimum, TCP/IP Ethernet shall be supported. The Offeror shall coordinate the efforts of the necessary parties (equipment suppliers) to accomplish the required device and data table addressing between each PLC and the associated connected equipment.

H. Additional communication modules or protocol gateways may be required to support specific communication protocols required under this Contract, and shall be supplied at no extra cost to the Owner.

2.04 INPUT/OUTPUT SUBSYSTEMS

A. Input/output hardware shall be plug-in modules in associated I/O backplane/chassis or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.

B. Discrete inputs shall be 120 VAC signals (integral to the PLC) from dry field contacts. Discrete outputs shall be 120 VAC outputs sourced from the PLC, or dry relay contacts (2A minimum) as required. Refer to Section 17060S – Signal Coordination Requirements for further details of discrete signal type and voltage requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 17550. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 32 per input module and 16 per output module.

C. Analog input circuits shall be isolated, minimum 16-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTD's. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Lightning/surge protection shall be provided as specified in Section 17560 - Surge Protection Devices. Maximum density for analog I/O modules shall be 8 per module.

D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting mode, or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

E. Input/output modules shall be as follows to match existing installations:

Input/Output Type	Module
Discrete Input	1756-IA16
Discrete Output	1756-OA16

Analog Input	1756-IF16
Analog Output	1759-OF8

F. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

2.05 REMOTE I/O SUBSYSTEMS

A. PLC backplane type I/O or field modules as manufactured by the PLC manufacturer. Field modules shall meet the requirements of Subsection 2.04, Input/Output Subsystems. Remote I/O processor or communication modules shall be modular and individually replaceable.

B. Remote I/O shall communicate with the PLC using the PLC manufacturer’s standard protocol or an open standard network such as Ethernet IP.

C. Remote I/O shall be connected through communication modules described in paragraph 2.03. RIO shall be daisy chained to create a device level ring using Ethernet/IP.

2.06 INPUT/OUTPUT CIRCUIT ARRANGEMENT

A. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one loop or piece of equipment.

2.07 PROGRAMMING SOFTWARE

A. The PLC programming and configuration software shall be the manufacturer's latest, full-featured version, Windows-based, and shall be fully compliant with IEC 61131-3 standards. The software package shall consist of all programming, configuration, configuration of network cards, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. PLC programming software shall include documentation on optical media.

B. A minimum of one copy of the PLC programming software shall be purchased by the Offeror and registered to the Owner.

C. All configuration and programming software necessary shall be provided on the computer specified in Section 17170 – Portable Notebook Computers for connection to the PLC processor via a communications port. All necessary hardware required to allow the notebook computer to perform PLC configuration and programming shall be provided.

D. If available, the configuration and programming software shall support communication over the network specified in Section 17180 – Process Control System Networks to implement its functions remotely from an operator workstation. All configuration and programming software necessary to implement this functionality shall be provided on the HMI Server operator workstations specified in Section 17140 – Operator Workstations. All necessary hardware required to have the operator workstation perform PLC configuration and programming shall be provided.

PART 3 - EXECUTION

3.01 REQUIREMENTS

A. PLC programming shall be furnished to perform all functions described in Section 17950 – Functional Control Descriptions (as submitted by Offeror), including global functions. In addition, PLCs shall be programmed to provide additional functions described in other sections of this Division.

B. PLC programming shall make use of the various IEC languages as appropriate to the specific task, and shall be performed in a modular style making extensive use of program blocks (subroutines) and program variables to be passed to the program blocks for specific equipment. It is the intent of this requirement to allow for enhanced readability and ease of modification of the program code through the elimination of multiple instances of repeated code for the same function in a "hard-coded" style.

C. Firmware revision shall be approved by the Engineer/Owner in order to coordinate support with existing facilities.

D. Comments are to be on the program elements as well as the individual rungs or function blocks. All source code shall be delivered to the Owner without password protection upon completion of the project. Proprietary code, function blocks, or AddOn Instructions (AOIs) are not permitted.

E. Refer to Section 17000S, Part 3 for additional requirements.

3.02 REQUIREMENTS FOR MANUFACTURER-SUPPLIED PLCs

A. PLCs that are supplied for equipment local control panels by individual equipment manufacturers or suppliers shall, where so indicated on the Control System Architecture Drawing, be integrated into the plant control system. The manufacturer-supplied PLC shall be furnished, installed and programmed by the manufacturer. The PLC shall continuously monitor and control the associated system and at the same time shall provide all the required alarms, indications of system parameters, equipment status, etc. to the main control system at the plant.

B. Where required as described above, each manufacturer-supplied PLC shall be connected to the Ethernet process control network for access from the plant control system HMI servers, as specified in Section 17180S, and shall contain a fiber optic Ethernet switch identical to those provided for the rest of the network-connected PLCs.

C. Manufacturer-supplied PLCs shall be ControlLogix or CompactLogix as manufactured by Rockwell Automation/Allen-Bradley and shall comply with all applicable requirements listed herein.

D. Each equipment manufacturer shall provide all monitoring and control data to be transferred between the PLC and the plant control system in contiguous blocks of PLC registers to facilitate block read and write commands for efficient scanning by the control system SCADA servers. These contiguous registers shall be arranged in a single data transfer area, which shall be divided into eight distinct areas with an emphasis on flexibility and future expansion. The distinct areas shall be arranged by data type (analog or discrete), transfer direction (server to PLC or PLC to server), and, where applicable, implementation schedule (current or future). Where required, peer-to-peer communication between PLCs shall likewise be accomplished using separate blocks of contiguous registers. Where individual equipment PLCs are not required to be connected to the plant control system via the data highway network, they shall provide the individual hardwired signals as specified in the Contract Documents. Data and commands for connection to the control system are described in the Drawings, the Input/Output Schedule, the individual equipment specification sections, and in Section 17950S – Functional Control Descriptions (as submitted by Offeror).

E. The operator interface for control of each individual system shall be performed by local operator interface units as specified in Section 17125S or individual pilot devices on the equipment local control panel, as specified in the associated equipment specification section. Additional operator interface functions shall be provided through the plant control system as specified in the respective equipment specifications and in Section 17950.

F. Where operator interface and control functions are required to be provided through the plant control system, the individual system supplier shall be responsible for coordination with the instrumentation subcontractor to provide a complete and working equipment control system. The individual equipment supplier shall also be responsible for limiting the access of the plant control system to the equipment PLC code so as to prevent malfunctions of the equipment and any failure to continuously perform its intended functions. The equipment supplier shall be responsible for ensuring that no actions by the plant control system can damage or otherwise adversely affect the operation of the associated equipment or the safety of personnel working on or near that equipment. The equipment supplier shall also provide direction in the configuration of the SCADA software's security system by the instrumentation subcontractor to limit access to the control functions of the equipment control system to authorized personnel only. The equipment supplier shall coordinate testing of the completed system with the Contractor, which shall conform to the requirements of Section 17072S – Field Testing.

G. The Contractor, Offeror, and instrumentation subcontractor shall coordinate testing and startup of the equipment provided by the equipment supplier with the plant control system, including but not limited to the following tasks:

1. Provide assistance with control system testing of inputs, outputs, and control strategies as needed.

2. Provide support or interface work necessary to perform physical checkout and field testing to the final field devices. The schedule may require the instrumentation subcontractor and equipment manufacturer personnel to perform loop checks simultaneously, as directed by the Engineer.

3. Coordinate and assist as needed to maintain I/O connectivity throughout the system.

4. Ensure personnel safety while equipment is exercised via the plant control system.

5. Ensure that process, instrumentation, and control equipment are not damaged while equipment is exercised via the plant control system.

6. Provide temporary modifications to field devices and their terminations, if needed.

7. Providing labor and supervision, which may include, but is not limited to, the following: electricians, instrument technicians, manufacturer's representatives, and individual(s) knowledgeable about process startup and operation.

8. Operation of process equipment for verification of each plant control system input and output.

- END OF SECTION -

SECTION 17125S

OPERATOR INTERFACE UNITS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation all operator interface unit, with all spare parts, accessories, and appurtenances as herein specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17100S – Digital System Hardware Configuration

C. Section 17120S – Programmable Logic Controllers

PART 2 -- PRODUCTS

2.01 OPERATOR INTERFACE UNIT – LARGE

A. An Operator Interface Unit (OIU) shall be provided to view and change PLC monitoring and control parameters and to display alarm messages using a graphical user interface. The OIU shall provide the following features as a minimum:

1. Minimum of 10.4-inch diagonal display
2. 18-bit color TFT LCD display of 640 X 480 pixels
3. Resistive film touch screen interface
4. Minimum of 512 MB internal storage
5. Minimum of 512 MB RAM application memory
6. 1.0 GHz CPU
7. Windows CE Operating System
8. Battery-backed real-time clock
9. SD, 2 USB-A, 1 Mini-USB-B, and PCI interfaces
10. RJ-45 Ethernet communication interface, 10/100 Mb auto selecting
11. RS-232 serial port
12. Windows-based configuration software complete with download cable
13. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
14. Enclosure Rating: NEMA 12/4X to match the associated PLC cabinet rating
15. Environment: 0-55°C, 5-95% relative humidity, non-condensing

B. The operator interface unit shall be Allen-Bradley PanelView Plus 7 1000. No substitutions allowed.

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PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. One copy of the latest version of the manufacturer's development/programming software, FactoryTalk View Machine Edition, shall be provided and turned over to the Owner.

B. All necessary configuration and programming of the OIUs will be performed by the Owner.

C. Unless otherwise noted, each OIU shall be mounted between 48 and 60 inches above the floor or work platform.

D. Refer to Section 17000S for additional requirements.

- END OF SECTION -

SECTION 17180S

PROCESS CONTROL SYSTEM NETWORKS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation IEEE 802.3 Ethernet local area network(s) for communications among plant devices.

B. Local area network shall be provided with all spare parts, accessories, and appurtenances as herein specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17120S – Programmable Logic Controllers

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. The following specific spare parts items shall be provided:

1. One spare switch of each type furnished under this Contract.

PART 2 -- PRODUCTS

2.01 LOCAL AREA NETWORK (LAN)

A. An IEEE 802.3 Ethernet local area network shall be used for communications between plant devices.

B. Network wiring shall be unshielded, twisted-pair copper cables for connections within buildings. Fiber optic media shall be used for all inter-device communication links extended outside of a building, unless specifically noted. Cables shall be as specified herein.

C. The Offeror may provide a network configuration different from that shown in the Contract Drawings with written approval of the Engineer, and coordinate with all affected trades and pay for all additional charges incurred.

D. The Offeror shall supply all hardware, cables, connectors, and software to implement a network as specified herein and shown on drawings.

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2.02 INDUSTRIAL ETHERNET NETWORK SWITCHES

A. Except where specifically allowed on the Control System Architecture Drawing, industrial

Ethernet network switches shall be provided for each device connected to the process control system network. The switches shall create switched Ethernet networks that conform to the IEEE 802.3 and 802.3u standards using copper wires or optical fibers in a bus, tree or ring network topology as shown on the Drawings. Ethernet network switches shall be modular, rack mounted, or standard DIN-rail mounted within the PLC cabinet or in an adjacent communication cabinet, as shown on the Drawings.

B. Ethernet network switches shall support ring, bus, tree, or point-to-point network topologies. On-line signal monitoring shall be provided to detect and locate impending faults. Ethernet network switches shall be replaceable on-line without disrupting the network. The Ethernet network switches shall be integrated into the in-plant Ethernet network to form a redundant ring network with self-healing communication recovery. Switches shall support the non-proprietary Media Redundancy Protocol (MRP) and Rapid Spanning Tree Protocol (RSTP) in addition to the switch manufacturer's standard redundant ring network protocol, all of which shall provide self-healing communication recovery.

C. Ethernet network switches shall meet the following minimum performance requirements:

Functions: Modular managed switch with store and forward switching mode, 10 Mbps Ethernet, or 100 Mbps Fast-Ethernet, or gigabit Ethernet support, multi-address capability, auto-crossing, auto-negotiation, auto-polarity. Port speed and duplex auto-negotiation shall be configurable. Each network switch shall manage up to eight (8) ports possible via integrated media modules specified below.

Management: Simple Network Management Protocol (SNMP) (v2/v3) and Common Industrial Protocol (CIP) support; IGMP filtering and snooping.

Power Requirements: Redundant 24 VDC power supply

Operating Temperature: 0° - 60°C

Relative Humidity: 10 - 95%

Network Size: Up to 50 nodes in ring structure

Port Type & Quantity: (at each PLC location)

- As required; minimum of four eight (48) 10/100Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment

- Two (2) 100/1000Base-FX, multimode fiber optic cables (62.5/125 μm), LC, ST or SC sockets, 0-5000 meters LAN segment

Link Budget:	8 dB @ 1300 nm; 10 dB @ 850 nm
Wavelength:	850 or 1300 nm

D. Acceptable industrial Ethernet network switches shall be as manufactured by Cisco Systems, Hirschmann or Allen-Bradley.

2.03 UNSHIELDED TWISTED PAIR CABLE

A. The installer shall test and submit results to Engineer for review and approval/

B. Unshielded twisted pair cable for drops within buildings shall consist of 4 pair of 24 AWG copper conductors in a flame-retardant jacket. Cable shall be plenum rated (UL 910) and meet EIA/TIA-568 Category 6 specifications. Unshielded twisted pair cable shall be Hyper Grade Extended Distance cable as manufactured by Berk-Tek, Belden equivalent, or equal. Connectors shall be modular RJ-45 plug.

2.04 FIBER OPTIC CABLE

A. Fiber optic cable shall conform to the following specifications:

1.	Fiber Type:	Graded Index (GI) Multimode
2.	Fiber/Cladding Diameter:	62.5/125 microns
3.	No. Fibers:	12, Color-coded
4.	Cable Construction:	Loose Tube w/ Ripcords
5.	Filling:	Water Swellable Dry Block
6.	Armored:	No
7.	Central Member:	Dielectric (Kevlar)
8.	Rating:	Gigabit Ethernet
9.	Bandwidth:	200/500 MHz-km at 850/1300 nm
10.	Maximum Attenuation:	3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm
11.	Application Type:	Direct-burial/Conduit/Aerial
12.	Sheath:	UV Resistant
13.	Max. Tensile Load:	600 lb (2700 N) installation; 200 lb (890 N) long term
14.	Minimum Bend Radius:	7 in (17.4 cm) under maximum tensile load; 4.6 in (11.6 cm) unloaded (installed)
15.	Operating Temperature:	-40 to 70 degrees C
16.	Operating Relative Humidity:	0-100%

B. Fiber optic cable shall be ALTOS All Dielectric Loose Tube Optical Cable as manufactured by Corning Cable Systems, the Extended Performance Fiber Optic Cable Series as manufactured by Phoenix Digital, Inc., Belden equivalent, equivalent system by Optical Cable Corporation, or equal.

C. Fiber optic cable shall be tested on the reel before installation and then again after it is fully installed. Installer shall submit test reports to Engineer for review and approval.

D. Upon entering a cabinet, panel or console, loose tube fiber optic cable shall be broken out using fan-out kits and terminated in a fiber optic patch panel. All individual fibers shall be terminated and all connections shall be tested. Tight buffered cable shall then be routed to the individual destinations as needed (or loose tube cable for runs to other buildings). Cabinet-mounted patch panels shall be Cabinet-Mounted Interconnect Center (C-MIC) as manufactured by Corning Cable Systems, equivalent by Black Box, Inc., Optical Cable Corporation, or equal.

E. Where cable is required to be routed to numerous, separate destinations within a building, loose tube cable shall be broken out immediately upon entering the building, all individual fibers terminated in a patch panel, and tight buffered, plenum rated cable shall be routed to the individual destinations. Building patch panels shall be Wall-Mountable Interconnect Center (WIC) or Premises Interconnect Center (PIC) as manufactured by Corning Cable Systems, equivalent by Black Box, Inc., Optical Cable Corporation, or equal.

F. Fiber optic cable for installation within buildings shall comply with all applicable fire and building safety codes for such applications.

G. Fiber optic cable shall utilize mechanically spliced, field installable, SC, LC, or ST compatible connectors. Connections shall have a typical loss of 0.35 dB or better and shall provide stable optical performance after numerous ratings. Connections shall utilize physical contact terminations utilizing UV or heat cured adhesive. Where applicable, field terminations shall use a simple procedure requiring minimal training.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. The destination of all network data cables (both copper and fiber) leaving an enclosure, patch panel, or building shall be labeled at each end using industry-standard wire markers.

B. An installation report shall be generated for both fiber and copper cables after testing is complete.

C. Refer to Section 17000S, Part 3 of the Specifications for additional requirements.

- END OF SECTION -

SECTION 17190S

UNINTERRUPTIBLE POWER SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified.

A. One UPS shall be provided for each operator workstation and its peripherals (i.e. printer, network equipment, radio, etc.) provided under this Contract.

B. One UPS shall be provided for each programmable logic controller (PLC) or remote telemetry unit (RTU) and its appurtenant equipment provided under this Contract. However, courtesy receptacles in PLC and RTU cabinets shall not be powered by the UPS.

C. UPS's shall be mounted in or near enclosures containing digital hardware, unless otherwise specified or shown on the Drawings, as follows:

1. UPS's for operator's consoles shall be mounted within the consoles.

2. UPS's for control panels containing PLCs shall be mounted either within the cabinet or in an adjacent cabinet of suitable environmental rating.

3. UPS's for RTUs shall be mounted within the RTU cabinet.

4. Where the UPS is mounted within a dedicated enclosure, that enclosure shall be properly sized for heat dissipation and all other applicable requirements as specified in Section 17500S and its subordinate Sections.

5. Where the UPS is mounted within the PLC or RTU cabinet, it shall not interfere with access to other equipment or wiring within the panel (i.e., it shall not be necessary to move or remove the UPS to remove or service other panel-mounted equipment). For floor-mounted PLC cabinets with bottom wiring access (including those cabinets with legs), the UPS shall be placed on a dedicated shelf within the cabinet.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17100S – Control and Information System Hardware, General

C. Section 17120S – Programmable Logic Controllers

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1.03 SUBMITTALS

A. The Offeror shall submit UPS sizing calculations for all UPS’s furnished under this Contract in accordance with Section 17031S - Control and Information System Submittals.

PART 2 -- EQUIPMENT

2.01 UNINTERRUPTIBLE POWER SYSTEMS

A. Each UPS shall consist of a freestanding UPS module and battery modules as required to meet backup run time requirements.

B. UPS's shall be true on-line type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.

C. An automatic bypass switch shall be provided on UPS's of greater than 2 kVA capacity. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.

D. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.

E. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.

F. Each UPS shall meet the following requirements:

1. Input voltage shall be 117 VAC, single phase, 60 Hz.

2. Voltage regulation shall be +/-5 percent for line and load changes.

3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.

4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for PLC-based control panels, and 45 minutes for remote telemetry units.

5. A status monitoring and control panel shall be provided and shall include the following:

   a. Status indicating lights for both normal and abnormal conditions.

   b. Individual alarm contacts that shall close upon loss of the AC line, low battery level or operation of the static transfer switch. Contacts shall be wired to the closest discrete input subsystem. An alarm contact shall be included for UPS failure. Alternatively, an RS-232 or USB port shall provide UPS status to an operator workstation. All required interface software and hardware shall be provided.

   c. Circuit breaker for the AC input.

6. Sound absorbing enclosure.

7. EMI/RF noise filtering.

8. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.

G. UPS systems shall be Smart-UPS RT Series as manufactured by APC. No substitutions allowed.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17000S, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17200S

CONTROL AND INFORMATION SYSTEM SOFTWARE REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all control and information system software with all required programming and software appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17920 – Control System Input/Output Schedule

C. Section 17950 – Functional Control Descriptions

PART 2 -- PRODUCTS

2.01 SOFTWARE REQUIREMENTS

A. The Owner's existing SCADA (Human-Machine Interface or HMI) software, including but not limited to all relevant displays, alarm summary pages, data collection, and historical trending/reporting, shall be modified to include all work performed under this Contract.

B. The Owner's existing control system shall be modified to include the inputs and outputs specified in the Input/Output Schedule and in other Sections of this Division.

2.02 OVERALL SYSTEM CONFIGURATION

A. All HMI software configuration performed under this Contract shall be coordinated with the Owner and shall match in all possible respects the "look and feel" of the Owner's existing system. Major HMI software scope of work shall include but shall not be limited to the following:

1. Create new graphic displays showing the new facilities and functions described herein complete with all associated equipment and instrumentation.

2. Modify the existing plant overview display(s) for the SCADA system to include the new facilities and equipment, and create links to the new screens.

3. Modify existing alarm summary pages to incorporate new monitoring data into the alarm displays.

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4. Modify existing reports to include the additional monitoring points specified under this Contract.

5. Create new real-time and historical trends, and coordinate with the Owner appropriate grouping of the trend charts.

6. Update the system status display to include new hardware provided under this Contract.

B. Ladder logic resident in existing PLCs shall be configured to perform the functions described as specified herein and in Specification Section 17950. Specifically, the existing PLCs shall be programmed to accept the inputs specified in the Input/Output Schedule and to make this data readily available to the plant network, and shall be programmed to execute the logic necessary to implement all control functions associated with the scope of work specified under this Contract.

C. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Software design, implementation and checkout shall satisfy the requirements specified in the various Sections of Division 17S.

- END OF SECTION -

SECTION 17500S

ENCLOSURES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

B. Control enclosures shall be assembled, wired, and tested in the Offeror’s own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17100S – Control and Information System Hardware, General

C. Section 17510S – Cabinets and Panels

D. Section 17520 – Field Panels

E. Section 17550 – Panel Instruments and Accessories

F. Section 17560 – Surge Protection Devices

G. Section 17600S – Unpowered Instruments, General

H. Section 17700S – Powered Instruments, General

I. Section 17800S – Analytical Instruments, General

J. Section 17900 – Schedules and Control Descriptions, General

K. Refer to Division 16S for additional requirements for cable, circuit breakers, disconnect switches, etc.

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1.03 GENERAL INFORMATION AND DESCRIPTION

A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.

B. Either manufacturer-standard or custom cabinetry may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.

C. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Offeror shall examine plans and/or field inspect new and existing structures as required to determine installation requirements, and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Offeror shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050S - Tools, Supplies and Spare Parts. In addition, the spare parts items shall be provided as specified in the individual cabinet and panel specification sections (17510S).

PART 2 -- PRODUCTS

2.01 TERMINAL BLOCKS

A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Weidmuller, Wieland, Square D, or equal.

B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.

C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top (NEMA 12 cabinets only).

2. Thermostatically controlled, low noise internal air blowers (initial setpoint 75°F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure interior temperature alarm shall be displayed on the HMI.

E. Intrusion alarm switches shall be provided on all enclosures containing digital hardware and shall generate an alarm to the nearest PLC when any enclosure door is opened.

F. Terminals shall be marked with a permanent, continuous marking strip and include the use of wiring ferrules. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.

G. Wiring within cabinets, panels, and consoles shall require wiring ferrules, shall be installed neatly, and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16S of the Specifications, except that the minimum wire size for discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

H. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.

I. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring. Installed wiring shall not unduly bend or deform the installed plastic wireway. If excessive deformation occurs, Offeror should reroute, support, or modify wiring to alleviate this condition.

J. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.

K. All installed spare I/O hardware shall be wired along with live I/O wiring to the field wiring terminal blocks within the cabinet. Where space for spare I/O modules has been provided with the PLC backplane or DIN-rail mounting system, corresponding space for wiring, surge protection, and terminations shall be furnished within the cabinet.

L. A copper ground bus shall be installed in each cabinet, and shall be connected to the building power ground.

M. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 16123 - Building Wire and Cable. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 16123. Where applicable, the wire number shall be the ID number listed in the input/output schedules.

N. Wires and wiring ferrules shall be color coded as follows:

Equipment Ground - GREEN

120 VAC Power - BLACK
120 VAC Power Neutral - WHITE

120 VAC Control (Internally Powered) - RED
120 VAC Control (Externally Powered) - YELLOW

24 VAC Control - ORANGE

DC Power (+) - RED
DC Power (-) - BLACK
DC Control - BLUE

Analog Signal – BLACK/WHITE or BLACK/RED

O. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

P. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

Q. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power". Letters in the word "WARNING" shall be 0.75 inch high, white.

R. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

3.02 PAINTING/FINISHING

A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 9S for additional requirements.

B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.

C. Panels fabricated from stainless steel shall not be painted.

D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be painted.

3.03 INSTALLATION

A. Refer to Section 17000S for additional requirements.

- END OF SECTION -

SECTION 17510S

CABINETS AND PANELS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the cabinets and panels, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17100S – Control and Information System Hardware, General

C. Section 17500S – Enclosures, General

D. Section 17900S – Schedules and Control Descriptions, General

PART 2 -- PRODUCTS

2.01 CABINETS AND PANELS

A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.

B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.

C. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in storage/feed areas for chlorine or other applicable corrosive chemicals shall be of non-metallic construction, rated NEMA 4X, and fully compatible with the associated chemical.

D. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

E. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Doors for NEMA 4X cabinets shall be all stainless steel with three-point latches. Door hardware on NEMA 4X cabinets located in chemical storage/feed areas shall be non-corrosive in that environment.

F. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits.

G. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

H. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door. When deployed, the laptop shelf shall not be greater than 48 inches above finished floor. Laptop shelf shall be fitted to door with factory applied weld-studs. Weld discoloration and enclosure penetrations will not be accepted.

I. Unless otherwise noted, panel-mounted control devices (OIUs, hand switches, etc.) requiring operator access shall be mounted between 48 and 60 inches above the floor or work platform and shall be mounted in the upper 50% of the cabinet unless approved by Engineer/Owner.

J. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Saginaw Control and Engineering (SCE). The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500S for additional requirements.

- END OF SECTION -

SECTION 17600S

UNPOWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in operation process instrumentation (flow elements, pressure switches, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process controls as shown on the Drawings and as specified. The Offeror may elect to install primary elements (flowmeters, etc.) on process lines provided that the Contractor provides full onsite supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Contractor shall supervise installation of equipment provided under this Division where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Offeror shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17500S – Enclosures, General

C. Section 17698S – Instrumentation and Control System Accessories

D. Section 17700S – Powered Instruments, General

E. Section 17800S – Analytical Instruments, General

F. Unpowered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.03 TOOLS, SUPPLIES AND SPARE PARTS

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A. Tools, supplies and spare parts shall be provided as specified in Section 17050S.

B. In addition to the above requirements, the Offeror shall provide spare parts as specified in individual instrument specification sections.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, instruments shall be provided with enclosures to suit specified environmental conditions. Field-mounted devices shall be rugged and mounted on walls or pipe stanchions.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Equipment shall be located so that it is accessible for operation and maintenance. The Offeror shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

B. Field equipment shall be wall mounted or mounted on twoinch diameter pipe stands welded to a 10inch square 1/2inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

C. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

D. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

E. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5S of the specifications.

3.02 ADJUSTMENT AND CLEANING

A. The Offeror shall comply with the requirements of Division 1S of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or startup activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Offeror of his responsibility for meeting all specified requirements.

B. The Offeror shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Offeror shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

C. At least 60 days before the anticipated initiation of installation testing, the Offeror shall submit to the Engineer a detailed description, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation and control system.

D. Field instrument calibration requirements shall conform to the following:

1. The Offeror shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be properly ranged and calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The Offeror shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Offeror shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

- END OF SECTION -

SECTION 17650S

PRESSURE GAUGES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17600S – Unpowered Instruments, General

C. Section 17698S – Instrumentation and Control System Accessories

PART 2 -- PRODUCTS

2.01 PRESSURE GAUGES

A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".

B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed the approximately 75% of the full-scale range.

C. Features

1. Mounting: ½” NPT, lower stem mount type
2. Accuracy: 0.5% full scale
3. Case: Solid front, black phenolic material
4. Dial: White background and black letters
5. Glass: Shatterproof
6. Blow-out protection: Back
7. Pressure element: stainless steel bourdon tube
8. Movement: Stainless steel, Teflon coated pinion gear and segment
9. Gaskets: Buna-N

D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.

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E. Gauge size shall be 2" for line sizes up to 3" and 4½" for line sizes of 4" or greater.

F. Diaphragm seals and isolating ring seals shall be furnished in accordance with the requirements specified under Section 17698S - Instrumentation and Control System Accessories.

G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A ½" isolation stainless steel ball valve shall be provided for each gauge assembly.

H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600S, Part 3.

- END OF SECTION -

SECTION 17670S

LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the float level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17600S – Unpowered Instruments, General

PART 2 -- PRODUCTS

2.01 LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

A. Level switches of the direct acting float-operated design shall be comprised of a hermetically sealed, approximately 5 inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene or PVC jacket, with three conductor cable a minimum of 20 feet in length. Level switches containing mercury shall not be acceptable. Microswitches shall be SPDT minimum, rated for 5 amps at 115 VAC. Level switch construction shall be compatible with the process media within which it will be installed.

B. Unless otherwise specified, media specific gravity is 0.95 to 1.05. If utilized for chemical service, the level switch shall be compatible with the chemical and associated specific gravity.

C. Float hangers and supports shall be provided as shown on the Drawings. Float switches shall be Model ENM 10 as manufactured by Flygt, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600S, Part 3 of the specifications.

- END OF SECTION -

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SECTION 17675S

PRESSURE SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the pressure switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17600S – Unpowered Instruments, General

PART 2 -- PRODUCTS

2.01 PRESSURE SWITCHES

A. Pressure, vacuum, and differential pressure switches shall be single or dual action with an adjustable setpoint for the process requirement and/or as specified herein. Switches shall be diaphragm or piston operated and activate S.P.D.T. snap action switches on increasing or decreasing pressure. Minimum differential shall be less than 10 percent of the range. Deadband shall be adjustable. Allowable surge pressure shall be a minimum 1.5 times the range. Each pressure switch shall have visible scale.

B. Pressure switches shall have a contact rating of 10 amperes at 120 volts AC. Pressure switches shall be in NEMA 4X enclosures. Switches shall have a repeatable accuracy of 1 percent of range. Pressure switches shall be isolated from the process fluid by a diaphragm seal or an isolation ring in locations as shown on the Contract Drawings and/or as specified. Wetted parts materials shall be compatible with the process fluid for corrosion resistance. Pressure switches shall be manufactured by Ashcroft. No substitutions allowed.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600S Part 3.

- END OF SECTION -

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SECTION 17698S

INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17600S – Unpowered Instruments, General

C. Section 17700S – Powered Instruments, General

D. Section 16902S – Electric Controls and Relays

PART 2 -- PRODUCTS

2.01 INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

A. General: Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This subarticle shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

B. Process Tubing: Process tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37 degrees stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.

C. Power, Control and Signal Cables: Power, control and signal wiring shall be provided under Division 16S of the Specifications.

D. Chemical Diaphragm Seals: Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, all components shall be non-reactive with the process fluid in all cases. Refer to the Instrument Schedules for specific materials requirements. Seal shall have fill connection, 1/4-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements and shall be provided with 316 SS factory filled capillaries. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

E. Isolating Ring Seals: For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).

1. Full Line Size Isolating Ring Seals - For all grit/sludge/slurry/scum applications or wherever the associated pressure instrument is used for control purposes, the sensor body shall be full line size wafer design. Full line size isolating ring seals shall have 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in-line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Isolating ring seals shall be Onyx Model PSR.

2. Tapped Isolating Ring Seals - For all other solids bearing fluids, pressure shall be sensed via a minimum 1/2" diameter spool-type isolating ring seal mounted on a 1/2" pipe nipple at 908 from the process piping. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally. Tapped isolating ring seals for solids service shall be Onyx Isolator Ring.

3. All Isolating Rings shall include quick disconnect fittings, integral isolation valves, have the ability to add fluid and purge any air bubbles without removing the ring from the process pipe.

F. Filling Medium: The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10°F to +150°F. Filling medium shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.

G. Isolation Valves: Isolation valves shall be 1/2 - inch diameter ball valves with 316 stainless steel body, 316 stainless steel ball, except that materials of construction shall be suitable for the associated process fluid where applicable (i.e., chemical service).

H. Sirens: Sirens shall be UL Listed, heavy duty, AC motor driven, weatherproof type capable of producing a minimum of 111 dBA at 10 feet. Power supply shall be 120 VAC, 60 hertz. Siren shall be McMaster-Carr Model 6392T11, Federal Signal Corporation equivalent, Edwards Signaling Company equivalent, or equal.

I. Strobe Lights: Strobe lights shall be high profile with Type 304 stainless steel base. Light is rated NEMA 4. Light shall have an outer dome to provide extra lens protection. Lens color shall be as indicated on the Drawings. Available lens colors are amber, blue, clear, and red. Surface mount hardware shall be included. Power supply shall be 120 VAC, 60 hertz. Strobe light shall be McMaster-Carr Model 5848T71, Federal Signal Corporation equivalent, Edwards Signaling Company equivalent, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600S, Part 3 of the specifications.

- END OF SECTION -

SECTION 17700S

POWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation powered process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process control system as shown on the Drawings and as specified. Powered instruments are those instruments that require power (120 VAC or 24 VDC loop power) to operate. The Offeror may elect to install primary elements (flowmeters, etc.) on process lines provided that the Contractor provides full on-site supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Contractor shall supervise installation of equipment provided under this Division where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Offeror shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17072S – Field Testing

C. Section 17500S – Enclosures, General

D. Section 17600S – Unpowered Instruments, General

E. Section 17698S – Instrumentation and Control System Accessories

F. Section 17800S – Analytical Instruments, General

G. Powered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050S.

B. In addition to the above requirements, the Offeror shall provide one remote handheld configuration device for communication with all "smart" instruments furnished under this Contract. The devices shall be capable of performing configuration, test, and format functions from anywhere on the 4-20 mA signal loop for a particular transmitter or by direct connection. The configuration device shall be Fischer & Porter Model 50HC1000, Rosemount Model 375, or equal.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures which are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 (B) herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper-free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The Offeror shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices and include isolation valves where necessary to allow for work to be performed while a system is still in operation. Where the Contract Documents do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square by 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5S of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

6. All equipment shall be mounted allowing easy access for maintenance and calibration.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The Offeror shall comply with the requirements of Division 1S of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Offeror of his responsibility for meeting all specified requirements.

2. The Offeror shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any

published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Offeror shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

3. At least 60 days before the anticipated initiation of installation testing, the Offeror shall submit to the Engineer a detailed description, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

B. Field Instrument Calibration Requirements

1. The Offeror shall provide the services of verified factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. If the manufacturer's recommendations require calibration, each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The Offeror shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Offeror shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the Offeror shall perform a loop check. The Offeror shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test as specified in Section 17072S – Field Testing.

- END OF SECTION -

SECTION 17701S

MAGNETIC FLOW METERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17700S – Powered Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one portable primary head simulator and associated software for calibration and testing of magnetic flowmeter signal converters. The calibrator shall be furnished complete with rechargeable battery pack, test leads, spare battery pack, charger, carrying case and accessories. Calibrator shall be furnished by the flowmeter manufacturer and shall be fully matched to the instrumentation furnished.

PART 2 -- PRODUCTS

2.01 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a 316 stainless steel or carbon steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, hard rubber, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes.

D. Grounding rings shall be provided for both ends of all meters.

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E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C. Meter and transmitter housings shall meet NEMA 4X/IP66 requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Where the flow tube is subject to submergence through installation in a meter vault or similar location, the flow tube assembly shall be rated NEMA 6P/IP68 and electronics shall be factory sealed against moisture intrusion. The use of field kits for modifying NEMA 4/4X/IP66 flow tubes to submergence duty shall not be acceptable. The associated transmitter shall be located in an area not subject to submergence.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. The remote configuration device shall be as specified under Section 17700S. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.30% of rate over the flow velocity range of 1.0 to 10.0 m/s (3.0 to 33 ft/sec) and 0.5% between 0.1 m/s and 1.0 m/s (1-3 ft/s). Repeatability shall be ± 0.1% of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°C. Power supply shall be 115 VAC, 60 Hz.

M. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

N. Magnetic flow meter systems shall be as manufactured by Siemens, Endress + Hauser, Foxboro or Rosemount. No other manufacturers or models shall be allowed.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

B. Refer to Section 17700S, Part 3, for further requirements.

- END OF SECTION -

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SECTION 17710S

THERMAL DISPERSION AIR FLOW METERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the thermal dispersion gas flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17700S – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 THERMAL DISPERSION AIR FLOW METERS

A. Each flowmeter shall utilize a thermal dispersion type, stainless steel sensing element installed in the process piping as indicated on the Drawings. The element insertion length shall be approximately one-half of the pipe diameter, and all mounting accessories shall be provided. Sensing element and connection head shall be rated for Class I, Division 1, Group D hazardous areas. Sensing element diameter shall be ½" at a minimum. Compression ferrule shall be made of Teflon or equal.

B. The electronic transmitter shall be remotely mounted within 30 feet of the sensor. Interconnecting sensor cable shall be provided. Power supply to the transmitter shall be 120 VAC, 60 Hz.

1. Transmitters shall be housed in an explosionproof enclosure suitable for use in Class I, Division 1, Group D hazardous areas.

2. Transmitters shall have a 4-20 mA analog output and a local indicator with a 3-1/2 digit LCD display calibrated in SCFM.

C. Flow meters for air shall be Kurz 454FTB series or FCI ST100.

D. Flow meters for digester gas shall be Kurz 454 WGF or FCI ST100.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700S, Part 3.

B. Provide manufacturer's representative services to field-calibrate the flow curves for each of the flow meters for the most consistent accuracy over the required flow range using a traversal of the cross-section of the ducts.

- END OF SECTION –

SECTION 17760S

PRESSURE INDICATING TRANSMITTERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the pressure indicating transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17700S – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 GAUGE PRESSURE INDICATING TRANSMITTERS

A. Gauge pressure transmitters shall be of the capacitance type with a process-isolated diaphragm with silicone oil fill, microprocessor-based "smart" electronics, and a field adjustable rangeability of 100:1 input range. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.065 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits. Output shall be linear isolated 4-20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be -40 to 85 degrees Celsius at 0-100% relative humidity. Each transmitter shall have a stainless steel tag with calibration data attached to body.

B. The piezoresistive silicon pressure sensor shall be mechanically, electrically, and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA

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C. output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds. Total long term stability (frequency of calibration) shall be not less than 0.125% for five years.

D. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service.

E. Gauge pressure indicating transmitters shall be as manufactured by Siemens, Endress + Hauser, Rosemount, Foxboro, or equal.

2.02 DIFFERENTIAL PRESSURE INDICATING TRANSMITTERS

A. Differential pressure indicating transmitters shall be the same as the gauge pressure transmitters except for body specifications. Differential pressure units shall be furnished with close coupled stainless steel three valve manifold assembly. Manifold assembly shall be HEX Products Model HM, or equal.

B. The electronics sections of differential pressure transmitters shall contain user-selectable square root extractors to provide a linear 4-20 mA DC output proportional to flow, when activated. Square root extractor circuitry shall be activated only for incompressible fluid flow applications (i.e., water). Flow rates for compressible fluids (i.e., air) shall be calculated externally using line temperature and static pressure corrections as specified elsewhere in Division 17S. In addition, each flow transmitter shall be furnished with laminated flow versus differential pressure curves wall mounted adjacent to the transmitter.

C. Differential pressure indicating transmitters shall be as manufactured by Siemens, Endress + Hauser, Rosemount, Foxboro, or equal.

2.03 FLANGE MOUNTED LEVEL INDICATING TRANSMITTERS

A. Flange-mounted tank liquid level indicating transmitters shall be the same as gauge pressure transmitters except for body type.

B. The flange-mounted sensor shall consist of a special non-corrosive isolating diaphragm with fill fluid in a sealed capillary system to transmit liquid pressure to the sensing element. A second isolating diaphragm shall transmit pressure through the fill fluid to the sensing diaphragm in the center of the capacitance cell. An isolating diaphragm and fluid fill shall also be provided on the opposite side of the sensing diaphragm to convey atmospheric or reference pressure.

C. All mounting flanges, diaphragms, O-rings and materials used in construction shall be non-corroding, compatible with each other, and compatible with the liquid being measured.

D. Flange-mounted liquid level transmitters shall be as manufactured by Siemens, Endress + Hauser, Rosemount, Foxboro, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700S, Part 3 of the Specifications.

- END OF SECTION -

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SECTION 17770S

TEMPERATURE INDICATING TRANSMITTERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the temperature indicating transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17700S – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 TEMPERATURE INDICATING TRANSMITTERS

A. Temperature indicating-transmitters shall be microprocessor-based with "smart" electronics, capable of accepting direct inputs from 2-, 3-, or 4-wire, platinum, copper, or nickel resistance temperature detectors (RTD) from 10 to 1000 ohms, thermocouple inputs, direct millivolt sources, and resistance/potentiometer devices. The indicating-transmitter shall be a true 2-wire device capable of operating on voltages up to 45 VDC.

B. The accuracy of the transmitter's Digital-to-Analog converter shall be within 0.02 percent of span. An LCD digital display shall be provided, capable of displaying mA, degrees in any units, ohms, or mV. Digital accuracy (Pt 100 RTD) shall be 0.10 degrees C. The indicator-transmitter shall contain an analog-to-digital converter which shall convert the RTD input to a digital signal and send it to the transmitter's electronics for further processing. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds. Long term stability (frequency of calibration) shall be not less than 0.25% of reading or 0.25 degrees C for five years.

C. The transmitter assembly shall be furnished with all necessary hardware for proper mounting as recommended by the manufacturer. Indicating-transmitter shall be housed in a watertight enclosure meeting NEMA 4X requirements. Enclosure shall be suitable for wall or 2-inch pipe stand mounting.

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D. The transmitter shall provide a linear isolated 4-20 mADC output proportional to temperature.

E. The transmitter shall constantly monitor all aspects of the input circuitry and diagnose any system failures. If self-diagnostics detect a sensor burnout or transmitter failure, the analog output signal shall be driven either upscale or downscale to alert the user. Upscale and downscale burnout features shall be user-selectable.

F. Temperature measurement system shall be as manufactured by Siemens, Endress + Hauser, Rosemount, Foxboro, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700S, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17800S

ANALYTICAL INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the analytical instruments as scheduled in the following sections together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with the process control system as shown on the Drawings and as specified. The Offeror may elect to install sensors on process lines provided that the Contractor provides full on-site supervision during installation. Mounting of associated indicators, sensors, sampling pumps, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The Contractor shall supervise installation of equipment provided under this Section where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the analytical instrument served. The Offeror shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instruments furnished under this Section are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17031S – Control and Information System Submittals

C. Section 17072S – Field Testing

D. Section 17500S – Enclosures, General

E. Section 17600S – Unpowered Instruments General

F. Section 17698S – Instrumentation and Control System Accessories

G. Section 17700S – Powered Instruments General

H. Analytical instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050S.

B. Additional items as recommended by the analytical instrument manufacturers or as described for the specified analytical instrument sections shall be provided.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design, shall not be superseded by other products, and shall be verified prior to Factory Acceptance Testing. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520S, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure. Instruments critical to the process (turbidity, level, and pressure), require the use of a UPS to keep the instrument in operation during a power loss as specified in Section 17190S.

E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 B herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass (or equivalent) or PVC coated copper-free cast aluminum NEMA

4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

2.02 ANALYSIS INSTRUMENTS

A. Analytical instrumentation shall be provided by the Offeror as specified in Section 11200S.

B. Liquid samples shall not pass through housings containing analyzer electronics. Process fluid temperature will be within a range of 40 to 90 degrees F.

C. Where ambient temperatures will affect accuracy by more than 1 percent of span, a suitable isothermal enclosure with thermostatically controlled space heater shall be provided.

D. Sample assemblies shall be suitable for submersion or flow-through service as noted and shall be chemically inert to constituents of raw wastewater solids or other chemical environment, as scheduled. Where the sample is drawn prior to filtration, the sample assemblies shall be capable of handling solids and grease.

E. Each analyzer requiring reagents and/or other replaceable parts shall be furnished with sufficient chemicals and replaceable parts for startup and acceptance tests and the specified warranty period.

F. Offeror's submittals on these analyzers shall include information on monthly reagent consumption and a list of replaceable parts required for periodic maintenance and the recommended operating periods between replacements. Installation of analyzers and sample preparation shall be in accordance with the analyzer manufacturer's instructions.

G. Analysis instrumentation performance, accuracy and reproducibility shall be as prescribed in APHA/AWWA/WEF "Standard Methods for the Examination of Water and Wastewater", latest edition. For those measurements specified herein, for which performance characteristics are not listed in the above, the supplier shall state instrument performance characteristics. The "referee" method shall be as prescribed in EPA Methods for Chemical Analysis of Water and Wastes (1971).

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The Offeror shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices and include isolation valves where necessary. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square by 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5S of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

6. Equipment shall be mounted so that maintenance and calibration activities are easily accomplished.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. The Offeror shall comply with the requirements of Division 1S of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Offeror of his responsibility for meeting all specified requirements.

B. The Offeror shall provide the services of factory trained technicians in accordance with Section 17031S, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Offeror shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

C. At least 60 days before the anticipated initiation of installation testing, the Offeror shall submit to the Engineer a detailed description, in duplicate, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

D. Field instrument calibration shall conform to the following requirements:

1. The Offeror shall provide the services of verified factory trained instrumentation technicians in accordance with Section 17031, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments and specified chemicals of known values to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The Offeror shall provide a written calibration sheet to the Engineer for each

instrument, certifying that it has been calibrated to its published specified accuracy. The Offeror shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the Offeror shall perform a loop check as specified in Section 17072S – Field Testing. The Offeror shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

SECTION 17801S

pH ANALYZERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the pH analyzers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S - Information and Control System Scope and General Requirements

B. Section 17800S - Analytical Instruments, General

PART 2 -- PRODUCTS

2.01 pH SENSORS

A. pH sensors shall be encapsulated in liquid crystal polymer thermoplastic and utilize the differential electrode measurement technique. The sensors shall include an integral preamplifier capable of sending a signal over a 5 conductor shielded cable. The sensors shall have the following features and minimum performance requirements:

1. Glass process electrode in buffered pH 7 solution
2. Integral preamplifier
3. Integral temperature compensation sensor
4. Measuring range: 0-14 pH
5. Maximum pressure: 100 psig at 70°C
6. Sensitivity: ±0.01 pH
7. Stability: 0.03 pH per 24 hours, non-cumulative
8. Operating temperature: 0°C to 70°C
9. Material: Ryton material, or equally resistive and durable material
10. Sensor cable length: minimum of 10 feet or as shown on the Drawings

B. Sensors shall be submersion mounted and provided with a PVC mounting pipe and a PVC electrode protector, or as shown on the Drawings.

C. Sensors shall be pHD sc Digital Differential pH sensors by Hach, Orbipore CPS91D by Endress & Hauser, or equal.

012506BR

2.02 pH TRANSMITTERS

A. pH transmitters shall be microprocessor-based with a non-volatile memory for calibration data. Transmitters shall be capable of accepting a signal from the sensors specified herein and shall provide a linear, isolated 4-20 mA DC proportional output signal. The transmitters shall have the following features and minimum performance requirements:

1. NEMA 4X enclosure suitable for outdoor service
2. Nominal input power: 120 VAC, 60 Hz
3. Ambient conditions: -4°F to 140°F, 0-95% relative humidity, with less than 7W sensor load
   -4°F to 104°F, 0-95% relative humidity, with less than 25W sensor load
4. Graphic dot matrix LCD, 128 x 64 pixels with LED backlighting
5. Panel face configuration keypad
6. Temperature compensation
7. Control functions: PID, high/low phasing, setpoint, deadband, overfeed timer, off delay, and on delay
8. Alarms: dual high/low alarms, on/off delays
9. Self diagnostics
10. Automatic calibration with buffer recognition
11. Three relay outputs

B. Controller shall be by the same manufacturer as the sensor and shall be the sc 100 Controller by Hach, Liquisys M CPM 253 (with Memosens technology) by Endress & Hauser, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17800S, Part 3.

- END OF SECTION -

SECTION 17803S

CONDUCTIVITY ANALYZERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the conductivity analyzers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S - Information and Control System Scope and General Requirements

B. Section 17800S - Analytical Instruments, General

PART 2 -- PRODUCTS

2.01 CONDUCTIVITY SENSORS

A. Conductivity sensors shall have the following features and minimum performance requirements:

1. Graphite electrodes
2. Integral preamplifier
3. Integral Pt RTD temperature compensation sensor
4. Measuring range: 0.057 uS/cm – 200,000 uS/cm
5. Maximum pressure: 300 psig at 150°C
6. Accuracy: ±2% of reading above 200 uS/cm
7. Operating temperature: -20°C to 150°C
8. Material: Ryton material, or equally resistive and durable material
9. Sensor cable length: minimum of 6 m or as shown on the Drawings

B. Sensors shall be pipe mounted and provided with all necessary mounting hardware.

C. Sensors shall be Digital Conductivity sensors by Hach, equivalent by Endress & Hauser, or equal.

2.02 CONDUCTIVITY CONTROLLERS

A. The microprocessor-based conductivity controller shall be compatible with the conductivity sensor. The controller shall receive a signal from the sensor, condition it, and amplify the signal for display and transmission.

B. Controllers shall meet the following minimum functional requirements:

062317BR

1. Housing: NEMA 4X
2. Power Supply: 115 VAC, 60 Hz
3. Operating Temperature: -20 - +60 C, 0-95% relative humidity, non-condensing

C. The controller shall have three relay contact outputs that can be activated based on the nitrate level. Relay outputs shall be programmable for various alarms and warning conditions that occurred internally within the system or with the process conditions. Relays shall be Form-C SPDT contacts rated at 5A, 115/230 VAC. The control and alarm setpoints for the relays shall be adjustable across the full operating range. LED lights at the controller shall indicate that the relay is energized. The analyzer shall have two linear, isolated 4-20mA assignable outputs.

D. The controller display shall be transreflective dot matrix LCD display with LED backlight, 240 x 160 pixels. The controller shall have diagnostic screens for messages, including scrolling lists for failure and warning alarm conditions, calibration records, and hardware tests.

E. Conductivity controllers shall be the sc200 Universal Controller as manufactured by Hach, equivalent by Endress & Hauser, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17800S, Part 3.

- END OF SECTION -

SECTION 17811S

LUMINESCENT DISSOLVED OXYGEN ANALYZERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the dissolved oxygen analyzers with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S - Control and Information System Scope and General Requirements

B. Section 17800S - Analytical Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. One complete spare sensor of each type used shall be provided.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Dissolved oxygen sensors shall be of the luminescent type.

B. Handrail-mounting hardware for the D.O. sensors, analyzers, and cleaning systems shall be furnished by the manufacturer for each sensor location, as shown on the Drawings. Mounting hardware for the D.O. sensors shall be installed by the Contractor in accordance with the manufacturer's requirements and recommendations. D.O. analyzer mounting hardware shall be the manufacturer's standard mounting hardware, shall allow the probe to be removed from the process without tools so that it may be cleaned, and shall secure and cushion the probe's signal cable to ensure it does not get damaged as the probe moves in the process tank. Mounting hardware shall submerge the sensor head 12 to 24 inches below the water surface.

2.02 LUMINESCENT DISSOLVED OXYGEN SENSORS

A. Luminescent-type sensors shall be based on luminescent technology where blue light from an LED is directed onto a luminescent coating on the sensor cap, and the coating then emits red light that is detected by the sensor. The oxygen concentration is then correlated directly from the time of decay of the red light generated by the luminescent coating material. A red LED shall be used as an internal reference standard to maintain accuracy.

082613BR

B. Probes shall be factory calibrated; initial field calibration shall not be required. Calibration shall be performed via single-point procedure in 100% water saturated air.

C. Probes shall have an integral temperature sensor with its data made available to the controller.

D. The sensor shall be submersible and shall consist of a stainless steel probe body with a replaceable sensor head assembly coated with luminescent material. The sensor shall have an integral sensor cable with a quick disconnect plug for connection to the analyzer. It shall be the Contractor's responsibility to determine and provide the proper length of cable between the transmitter and the sensor.

E. Sensor specifications shall be as follows:

1.	Accuracy:	± 0.05 ppm < 1 ppm DO ± 0.1 ppm < 5 ppm DO ± 0.2 ppm > 5 ppm DO ± 0.2°C
2.	Repeatability:	$\pm$ 0.1 ppm
3.	Resolution:	0.01 ppm DO 0.1% saturation
4.	Measurement Range:	0-20.0 ppm
5.	Response Time:	T_{95} < 60 sec T_{90} < 40 sec @ 20°C
6.	Max. Immersion Depth:	34 m (112 ft) H_2O
7.	Operating Temp. Range:	0-50°C

F. Dissolved oxygen sensors shall be the Hach LDO Model 2, or equal.

2.03 DISSOLVED OXYGEN CONTROLLERS

A. The microprocessor-based dissolved oxygen controller shall be compatible with the luminescent dissolved oxygen sensor. The controller shall receive a signal from the sensor, condition it, and amplify the signal for display and transmission.

B. Controllers shall meet the following minimum functional requirements:

1.	Housing:	NEMA 4X
2.	Power Supply:	115 VAC, 60 Hz
3.	Operating Temperature:	-20 to +60°C, 0-95% relative humidity, non-condensing

C. The controller shall have three relay contact outputs that can be configured based on the dissolved oxygen level. Relay outputs shall be programmable for various alarms and warning conditions that occurred internally within the system or with the process conditions. Relays shall be Form-C SPDT contacts rated at 5A, 115/230 VAC. The control and alarm setpoints for the relays shall be adjustable across the full operating range. LED lights at the controller shall indicate that the relay is energized. The analyzer shall have two linear, isolated 4-20mA assignable outputs. Where scheduled or otherwise specified, the controller shall be furnished with Modbus RS232/485, Profibus DP, or HART communication capability.

D. The controller display shall be transreflective dot matrix LCD display with LED backlight, 240 x 160 pixels. The controller shall have diagnostic screens for messages, including scrolling lists for failure and warning alarm conditions, calibration records, and hardware tests.

E. Dissolved oxygen controllers shall be the Hach sc200 Universal Controller, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17800S, Part 3 of the specifications.

- END OF SECTION -

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SECTION 17823S

TURBIDITY ANALYZERS (PROBE-TYPE)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the turbidity analyzers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17800S – Analytical Instruments, General

PART 2 -- PRODUCTS

2.01 TURBIDITY SENSORS

A. Probe-type turbidity sensors shall be microprocessor-based and shall provide continuous monitoring. The sensor shall be equipped with a wiper blade cleaning system to periodically clear the sensor face.

B. Turbidity sensors shall be based on a combined infrared absorption scattered light technology where light emitted from an LED is scattered sideways by the turbidity particles and measured over an angle of 90 degrees by the sensor.

C. The sensor shall be submersible and shall consist of a stainless steel probe body. The sensor shall have an integral sensor cable with a quick disconnect plug for connection to the analyzer.

D. Turbidity sensors shall meet the following minimum functional requirements:

1. Sample Temperature: 0-40 degrees Celsius
2. Operating Temperature: 0-40 degrees Celsius
3. Detection Limit: 0.001 NTU
4. Accuracy: < 1% of reading or +/-0.001 NTU
5. Repeatability: < 1% of reading
6. Response Time: 1 second

E. Turbidity sensors shall be SOLITAX sc as manufactured by Hach, or equal.

2.02 TURBIDITY CONTROLLERS

A. The microprocessor-based turbidity controller shall be compatible with the turbidity

122711BR

sensor. The controller shall receive a signal from the sensor, condition it, and amplify the signal for display and transmission.

B. Controllers shall meet the following minimum functional requirements:

1.	Housing:	NEMA 4X
2.	Power Supply:	115 VAC, 60 Hz
3.	Operating Temperature:	-20 - +60 degrees Celsius, 0-95% relative humidity, non-condensing

C. The controller shall have three relay contact outputs that can be activated based on the turbidity level. Relay outputs shall be programmable for various alarms and warning conditions that occurred internally within the system or with the process conditions. Relays shall be Form-C SPDT contacts rated at 5A, 115/230 VAC. The control and alarm setpoints for the relays shall be adjustable across the full operating range. LED lights at the controller shall indicate that the relay is energized. The controller shall have two linear, isolated 4-20mA assignable outputs.

D. The controller display shall be transreflective dot matrix LCD display with LED backlight, 240 x 160 pixels. The controller shall have diagnostic screens for messages, including scrolling lists for failure and warning alarm conditions, calibration records, and hardware tests.

E. Controllers shall be sc200 Universal Controller as manufactured by Hach, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Provide all hardware necessary for mounting the sensors and controllers as shown on the Drawings and as described herein. Mounting hardware shall be provided at all locations shown on the Drawings including both installed and uninstalled spare instrument locations.

B. Contractor shall install the instruments in strict accordance with the manufacturer’s instructions and recommendations. The manufacturer or a manufacturer’s representative shall provide start-up service by a factory-trained technician.

C. The manufacturer’s standard annual service agreement shall be provided with all instruments furnished under this Section. The service agreement shall include all parts and labor required for all scheduled and unscheduled maintenance, and shall run from installation of the instruments until expiration of the warranty period specified in Section 11000S.

D. Refer to Section 17800S, Part 3 of the specifications.

- END OF SECTION -

SECTION 17841S

OPTICAL NITRATE ANALYZERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the optical nitrate analyzers with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17800S – Analytical Instruments, General

PART 2 -- PRODUCTS

2.01 GENERAL

A. Optical nitrate analyzers shall use the reagent-free, ultraviolet (UV) light absorption technique.

B. Mounting hardware for the nitrate sensors and analyzers shall be furnished by the manufacturer for each sensor location, as shown on the Drawings. Mounting hardware for the nitrate sensors shall be installed by the Contractor in accordance with the manufacturer's requirements and recommendations. Nitrate analyzer mounting hardware shall be Model LZX 414.00.10000 by Hach, with all accessories. Mounting pipe length shall be as required to submerge the sensor head a minimum of 24 inches below the water surface.

2.03 OPTICAL NITRATE SENSORS/CONTROLLERS

A. Optical-type nitrate sensors shall be based on UV-absorption technology using a two-beam technique. The sensor shall contain a UV light source at 210 nm and a corresponding photometer to directly measure nitrate concentration. A second 350 nm beam shall be used as a reference standard and to correct for interference caused by turbidity and organic matter. A built-in wiper shall be provided to automatically clean the sensor's detector windows.

B. The sensor shall conform to the following specifications:

03131 2BR

1.	Sensor Type	Submersible
2.	Measuring Gap/Path Length	1 mm 2 mm 5 mm
3.	Measuring Range	0.1 to 100.0 mg/L NO_{2+3}-N (1 mm) 0.1 to 50.0 mg/L NO_{2+3}-N (2 mm) 0.1 to 25.0 mg/L NO_{2+3}-N (5 mm)
4.	Accuracy	+/- 3% of the mean +/- 0.5
5.	Resolution	0.1 mg/L
6.	Measurement Interval	15 sec
7.	Response Time (T100)	15 sec
8.	Materials of Construction	Stainless steel with double seal
9.	Operating Temperature	2 to 40 C (36 to 104 F)
10.	Operating Pressure	0.5 bar (7.2 psi), max
11.	Sensor Cable	Integral w/ Quick Disconnect Plug

C. Gap length shall be as recommended by the manufacturer. Measuring range shall be as scheduled.

D. Optical nitrate sensors shall be the Nitratax plus sc sensor as manufactured by Hach, or equal.

2.03 OPTICAL NITRATE CONTROLLERS

A. The microprocessor-based nitrate controller shall be compatible with the nitrate sensor. The controller shall receive a signal from the sensor, condition it, and amplify the signal for display and transmission.

B. Controllers shall meet the following minimum functional requirements:

1.	Housing:	NEMA 4X
2.	Power Supply:	115 VAC, 60 Hz
3.	Operating Temperature:	-20 - +60 C, 0-95% relative humidity, non-condensing

C. The controller shall have three relay contact outputs that can be activated based on the nitrate level. Relay outputs shall be programmable for various alarms and warning conditions that occurred internally within the system or with the process conditions. Relays shall be Form-C SPDT contacts rated at 5A, 115/230 VAC. The control and alarm setpoints for the relays shall be adjustable across the full operating range. LED lights at the controller shall indicate that the relay is energized. The analyzer shall have two linear, isolated 4-20mA assignable outputs.

D. The controller display shall be transreflective dot matrix LCD display with LED backlight, 240 x 160 pixels. The controller shall have diagnostic screens for messages, including scrolling lists for failure and warning alarm conditions, calibration records, and hardware tests.

E. Optical nitrate controllers shall be the sc200 Universal Controller as manufactured by Hach, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Provide all hardware necessary for mounting the sensors and controllers as shown on the Drawings and as described herein. Mounting hardware shall be provided at all locations shown on the Drawings including both installed and uninstalled spare instrument locations.

B. Contractor shall install the instruments in strict accordance with the manufacturer's instructions and recommendations. The manufacturer or a manufacturer's representative shall provide start-up service by a factory-trained technician.

C. The manufacturer's standard annual service agreement shall be provided with all instruments furnished under this Section. The service agreement shall include all parts and labor required for all scheduled and unscheduled maintenance, and shall run from installation of the instruments until expiration of the warranty period specified in Section 17080S, Quality Assurance.

D. Refer to Section 17800S, Part 3 of the specifications.

- END OF SECTION -

SECTION 17843S

AMMONIUM ANALYZERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall install and the Offeror shall furnish, test and place in satisfactory operation the ammonium analyzers with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000S – Control and Information System Scope and General Requirements

B. Section 17800S – Analytical Instruments, General

PART 2 -- PRODUCTS

2.01 GENERAL

A. Ammonium analyzers shall use the ion-selective electrode (ISE) technique with a differential pH electrode as the reference, and a potassium ISE to correct the ammonium value for the presence of potassium ion.

B. An air blast cleaning system shall be furnished by the manufacturer and installed at each ammonium sensor mounting location. The air blast unit supply power shall be 120 VAC. The unit shall supply a minimum output air pressure of 45 psi. System shall be High Output Air Blast System as manufactured by Hach, or equal.

C. Mounting hardware for the ammonium sensors and analyzers shall be furnished by the manufacturer for each sensor location, as shown on the Drawings. Mounting hardware for the ammonium sensors shall be installed by the Contractor in accordance with the manufacturer's requirements and recommendations. Mounting hardware shall be as required to submerge the sensor head a minimum of 12 inches below the water surface, at least 4 inches above the bottom of the tank, and at least 12 inches from the wall of the tank.

2.03 AMMONIUM SENSORS

A. The ammonium sensor shall consist of a digital sensor with integrated, replaceable sensor cartridge. The integrated sensor cartridge shall include the ammonium ISE, differential pH electrode, potassium ISE, and temperature sensor.

B. The sensor shall conform to the following specifications:

122711BR

1.	Sensor Type	Submersible, 0.3 - 3.0 m (1 - 10 feet) max
2.	Measuring Range	0.2 to 1000 mg/L
3.	Accuracy	5% of measured value ±0.2 mg/L (with standard solution)
4.	Detection Limit	0.2 mg/L
5.	Response Time (T90)	< 2 min
6.	Materials of Construction	Stainless steel with Ryton ends
7.	Operating Temperature	-20 to 45 C (-4 to 114 F)
8.	Sample Temperature	0 to 40 C (32 to 104 F)
9.	Operating Pressure	0.3 bar (4.4 psi), max
10.	Sample pH	5 to 9
11.	Sensor Cable	Integral w/ Quick Disconnect Plug

C. Ammonium sensors shall be the NH4D sc Ammonium sensor as manufactured by Hach, or equal.

2.03 AMMONIUM CONTROLLERS

A. The microprocessor-based ammonium controller shall be compatible with the ammonium sensor. The controller shall receive a signal from the sensor, condition it, and amplify the signal for display and transmission.

B. Controllers shall meet the following minimum functional requirements:

1.	Housing:	NEMA 4X
2.	Power Supply:	115 VAC, 60 Hz
3.	Operating Temperature:	-20 - +60 C, 0-95% relative humidity, non-condensing

C. The controller shall have three relay contact outputs that can be activated based on the ammonium level. Relay outputs shall be programmable for various alarms and warning conditions that occurred internally within the system or with the process conditions. Relays shall be Form-C SPDT contacts rated at 5A, 115/230 VAC. The control and alarm setpoints for the relays shall be adjustable across the full operating range. LED lights at the controller shall indicate that the relay is energized. The analyzer shall have two linear, isolated 4-20mA assignable outputs.

D. The controller display shall be transreflective dot matrix LCD display with LED backlight, 240 x 160 pixels. The controller shall have diagnostic screens for messages, including scrolling lists for failure and warning alarm conditions, calibration records, and hardware tests.

E. Ammonium controllers shall be the sc200 Universal Controller as manufactured by Hach, or equal.

<u>PART 3 -- EXECUTION</u>

3.01 REQUIREMENTS

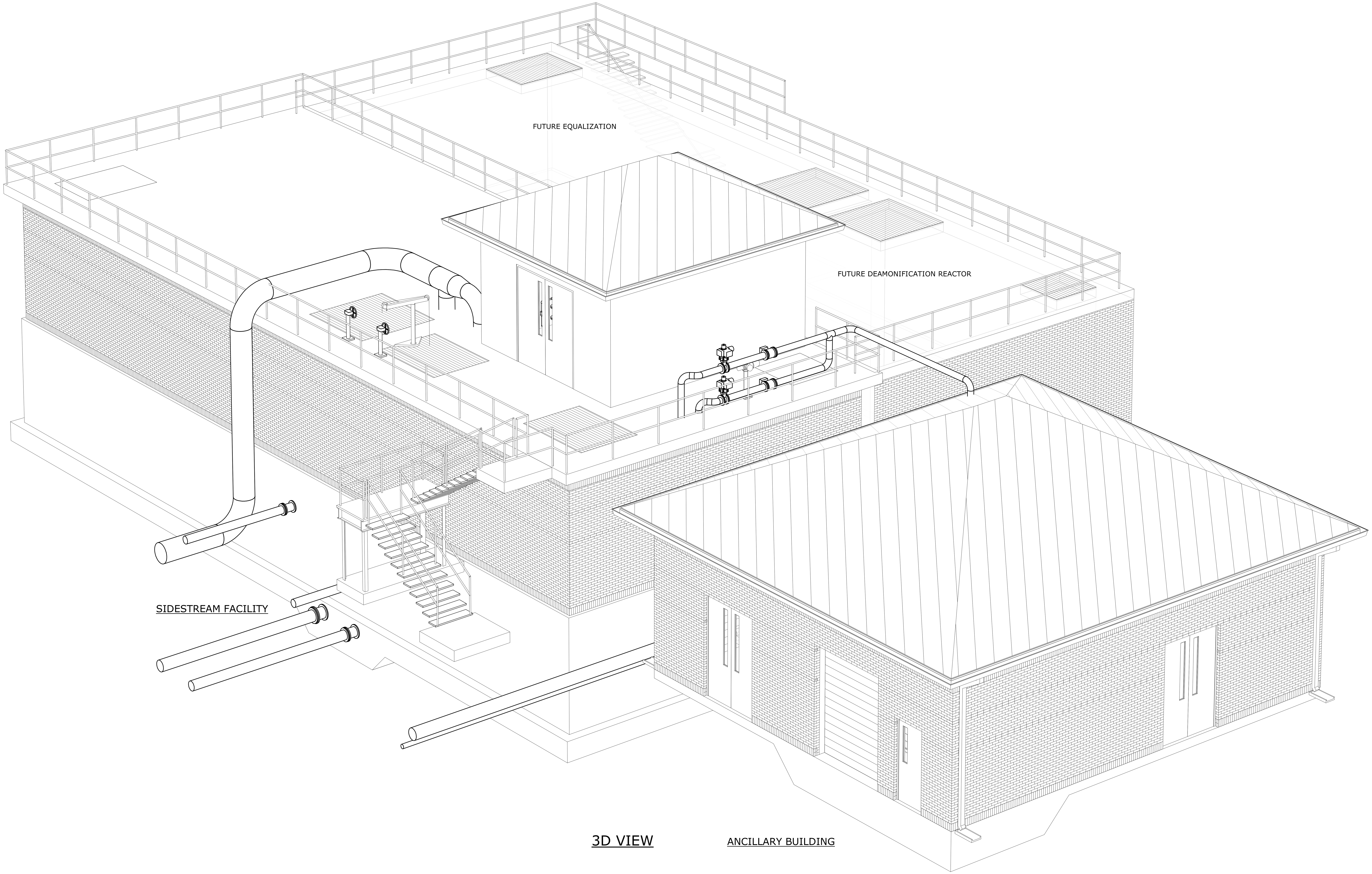
A. Provide all hardware necessary for mounting the sensors and controllers as shown on the Drawings and as described herein. Mounting hardware shall be provided at all locations shown on the Drawings including both installed and uninstalled spare instrument locations.

B. Contractor shall install the instruments in strict accordance with the manufacturer's instructions and recommendations. The manufacturer or a manufacturer's representative shall provide start-up service by a factory-trained technician.

C. The manufacturer's standard annual service agreement shall be provided with all instruments furnished under this Section. The service agreement shall include all parts and labor required for all scheduled and unscheduled maintenance, and shall run from installation of the instruments until expiration of the warranty period specified in Section 17080S, Quality Assurance.

D. Refer to Section 17800S, Part 3 of the specifications.

- END OF SECTION -



3D VIEW

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER: P. YI
DESIGNED BY: P. BASSETTE
DRAWN BY: C. BASTIN
CHECKED BY: J. CARROLL

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE — 0 1/2" 1"

PRELIMINARY DRAWING
DO NOT USE FOR CONSTRUCTION

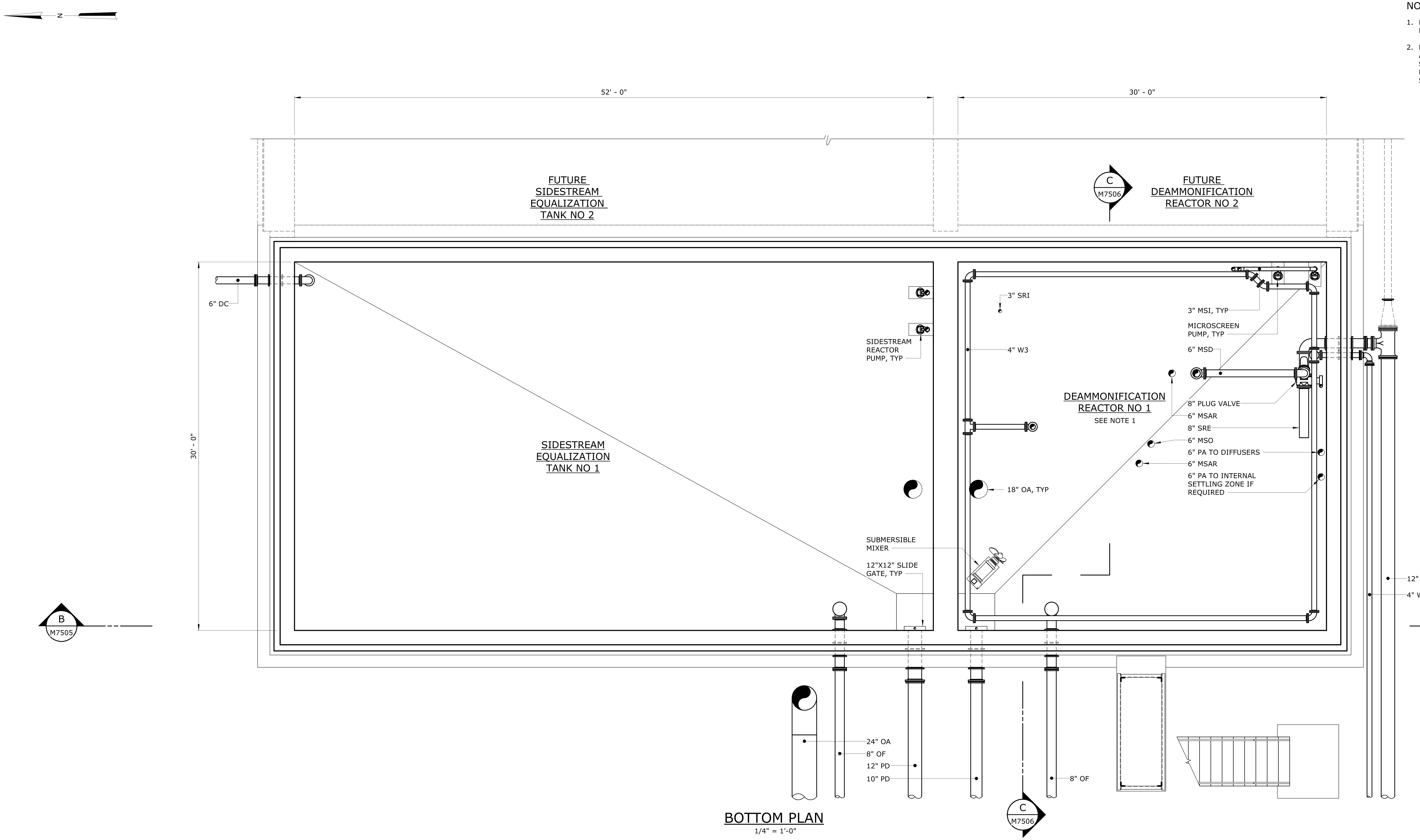
Hazen
HAZEN AND SAWYER
4035 RIDGE TOP ROAD,
FAIRFAX, VA. 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

SIDESTREAM DEAMMONIFICATION
FACILITY (75)
PROCESS MECHANICAL
3D VIEW

DATE: OCTOBER 2018
HAZEN NO.: 33000-006
CONTRACT NO.: BRW.00002
DRAWING NUMBER: M7501



BOTTOM PLAN

1/4" = 1'-0"

NOTES:

1. REACTOR INTERNALS TO BE PROVIDED BY OFFEROR.
2. DRAWING PROVIDED TO OFFEROR AS REFERENCE FOR THE OVERALL SYSTEMS LAYOUT. NOT ALL EQUIPMENT AND PIPING ARE SHOWN.

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	P. YI
DESIGNED BY:	P. BASSETTE
DRAWN BY:	C. BASTIN
CHECKED BY:	J. CARROLL
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"

PRELIMINARY DRAWING DO NOT USE FOR CONSTRUCTION

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD,
FAIRFAX, VA. 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

SIDESTREAM DEAMMONIFICATION FACILITY (75)
PROCESS MECHANICAL
BOTTOM PLAN

DATE:	OCTOBER 2018
HAZEN NO.:	33000-006
CONTRACT NO.:	BRW.00002
DRAWING NUMBER:	M7502

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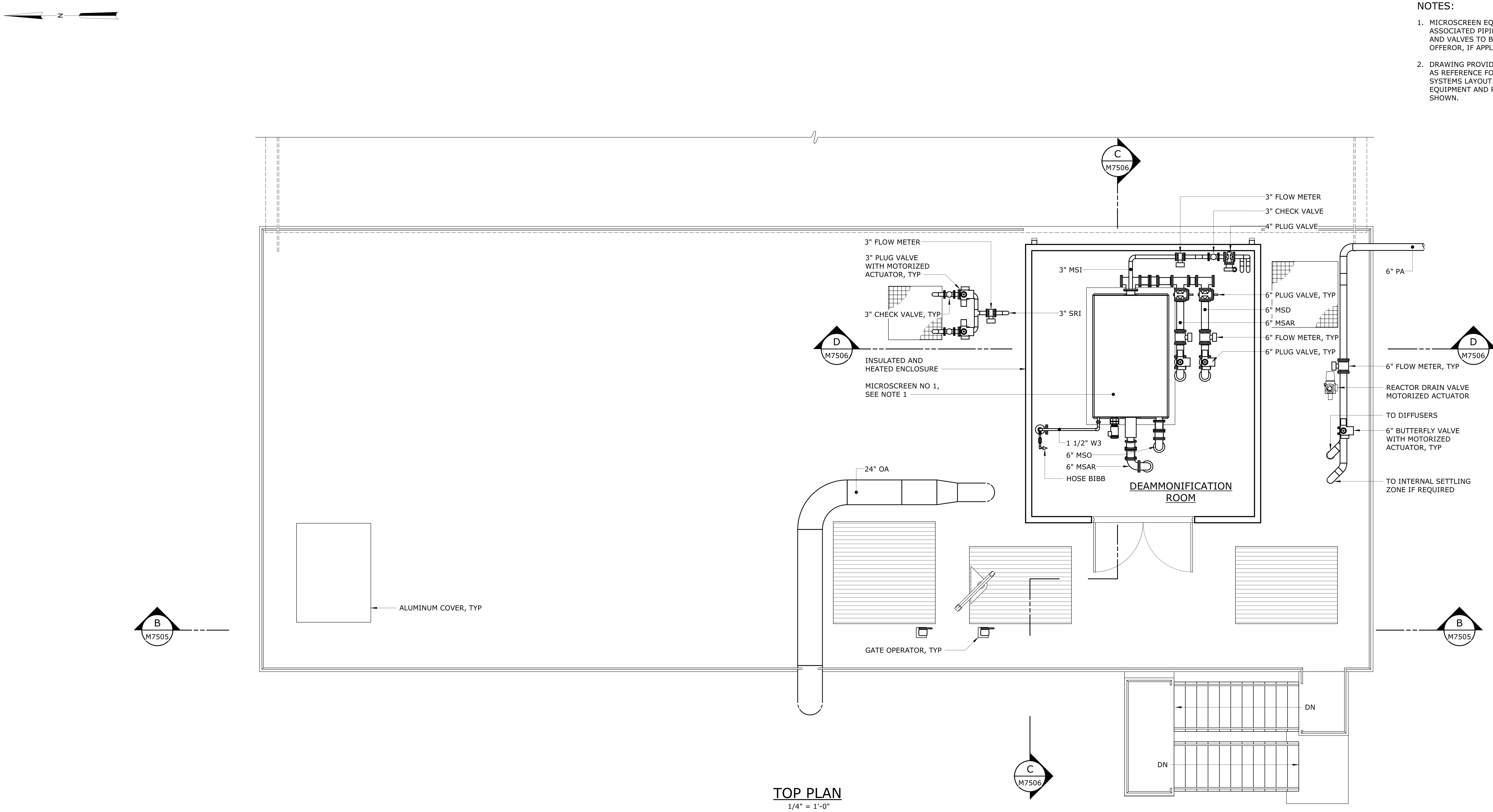

TOP PLAN
1/4" = 1'-0"

NOTES:

1. MICROSCREEN EQUIPMENT, ASSOCIATED PIPING, FITTINGS AND VALVES TO BE PROVIDED BY OFFEROR, IF APPLICABLE.
2. DRAWING PROVIDED TO OFFEROR AS REFERENCE FOR THE OVERALL SYSTEMS LAYOUT. NOT ALL EQUIPMENT AND PIPING ARE SHOWN.

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	P. YI
DESIGNED BY:	P. BASSETTE
DRAWN BY:	C. BASTIN
CHECKED BY:	J. CARROLL
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"

PRELIMINARY DRAWING DO NOT USE FOR CONSTRUCTION

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD,
FAIRFAX, VA. 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

SIDESTREAM DEAMMONIFICATION FACILITY (75)
PROCESS MECHANICAL
TOP PLAN

DATE:	OCTOBER 2018
HAZEN NO.:	33000-006
CONTRACT NO.:	BRW.00002
DRAWING NUMBER:	M7503

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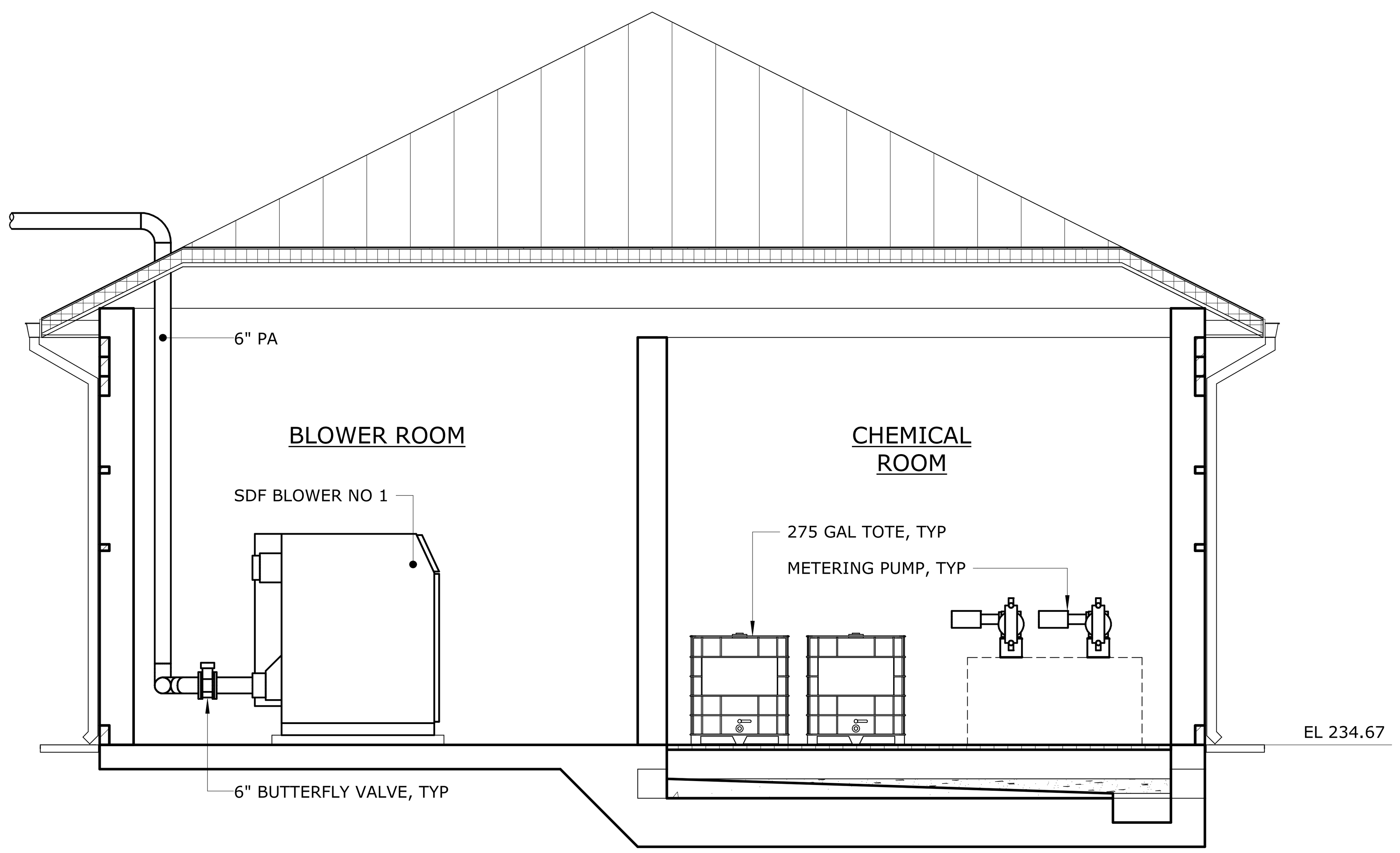
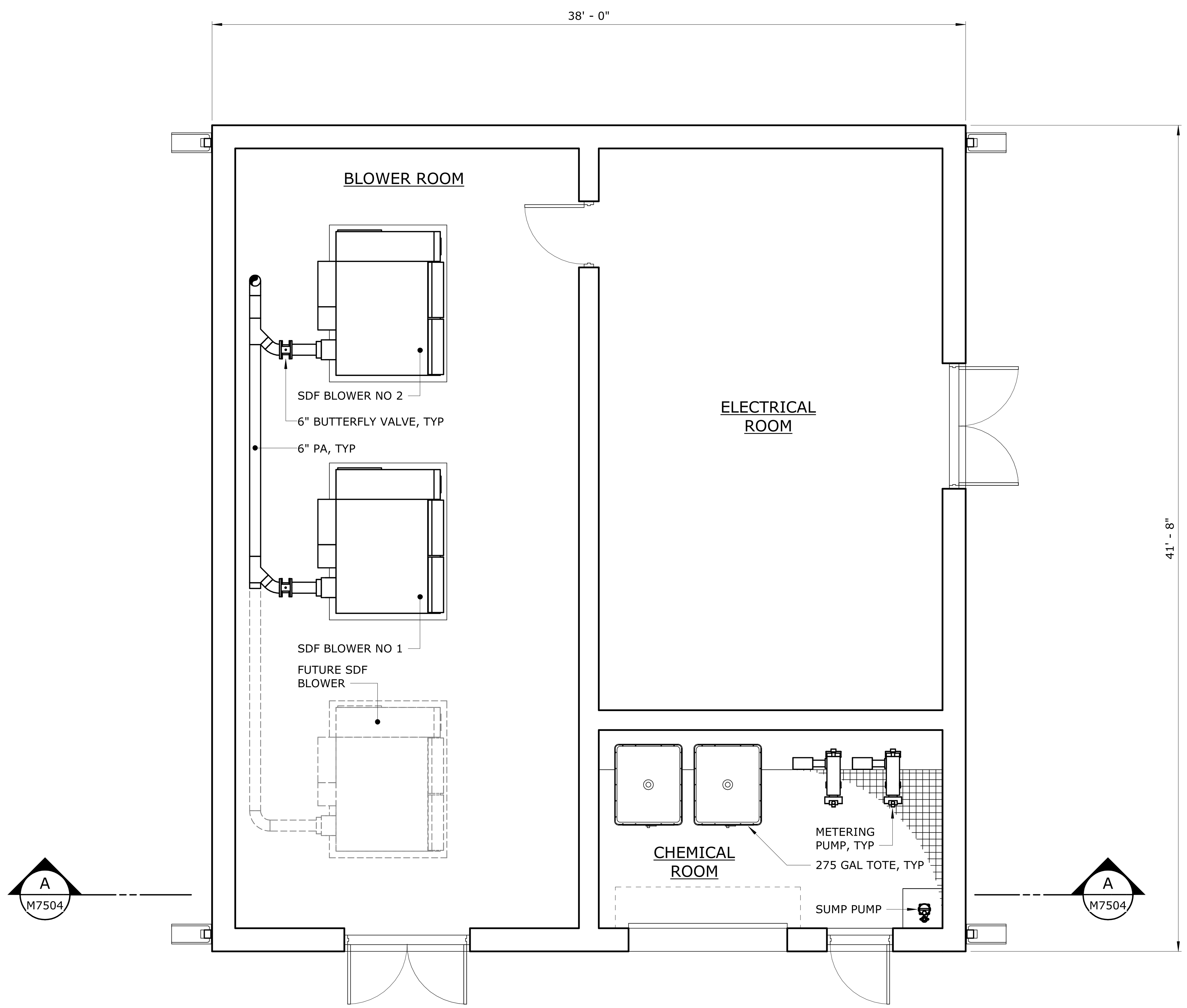


SECTION A M7504
1/4" = 1'-0"



FLOOR PLAN
1/4" = 1'-0"

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	P. YI
DESIGNED BY:	P. BASSETTE
DRAWN BY:	C. BASTIN
CHECKED BY:	J. CARROLL
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"

PRELIMINARY DRAWING
DO NOT USE FOR CONSTRUCTION

Hazen
HAZEN AND SAWYER
4035 RIDGE TOP ROAD,
FAIRFAX, VA. 22030

LOUDOUN WATER
BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

SIDESTREAM DEAMMONIFICATION FACILITY (75)
PROCESS MECHANICAL
ANCILLARY FLOOR PLAN

DATE:	OCTOBER 2018
HAZEN NO.:	33000-006
CONTRACT NO.:	BRW.00002
DRAWING NUMBER:	M7504

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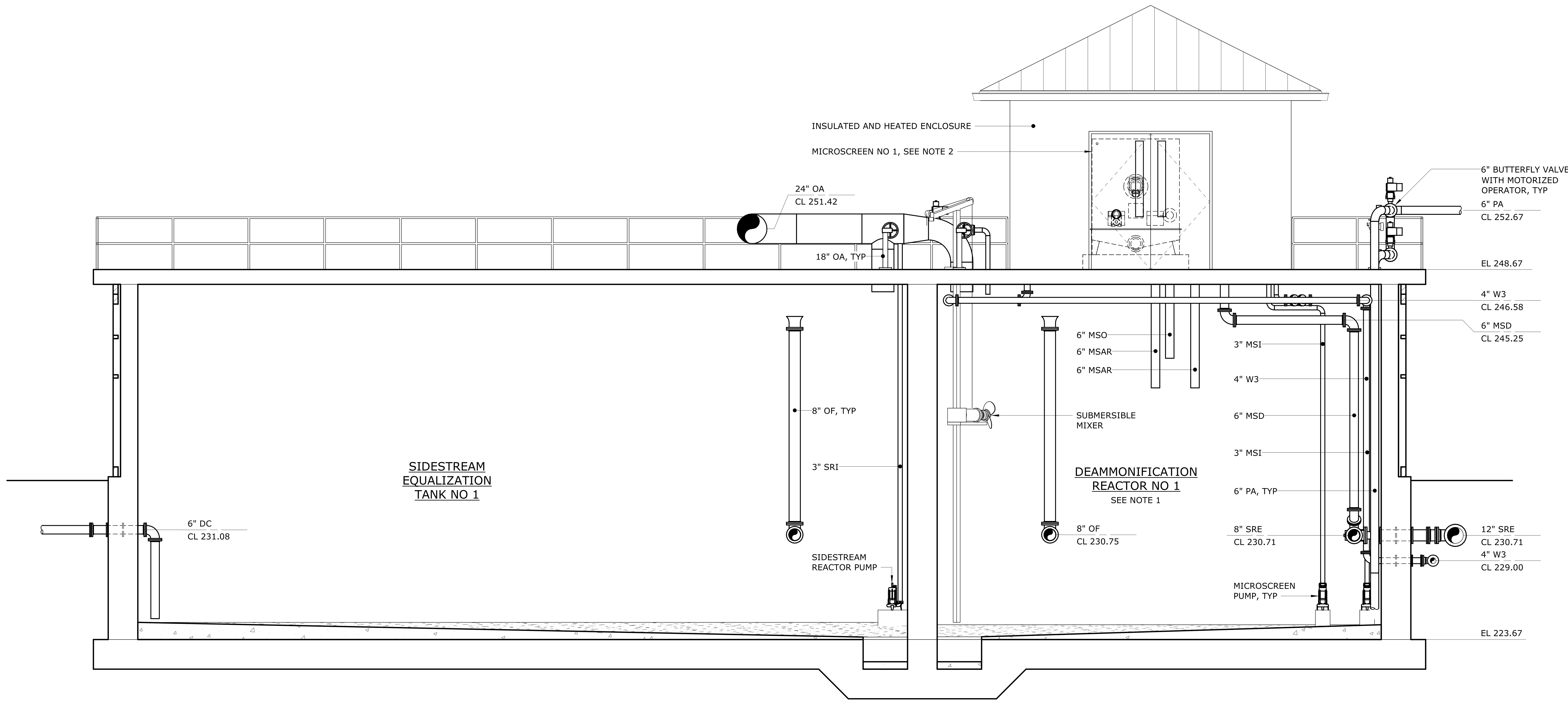
NOTES:

1. REACTOR INTERNALS TO BE PROVIDED BY OFFEROR.
2. MICROSCREEN EQUIPMENT, ASSOCIATED PIPING, FITTINGS AND VALVES TO BE PROVIDED BY OFFEROR, IF APPLICABLE.



SECTION B M7502

1/4" = 1'-0"

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER: P. YI

DESIGNED BY: P. BASSETTE

DRAWN BY: C. BASTIN

CHECKED BY: J. CARROLL

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE 0 1/2" 1"

PRELIMINARY DRAWING DO NOT USE FOR CONSTRUCTION

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD,
FAIRFAX, VA. 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

SIDESTREAM DEAMMONIFICATION FACILITY (75)
PROCESS MECHANICAL
SECTIONS

DATE: OCTOBER 2018

HAZEN NO.: 33000-006

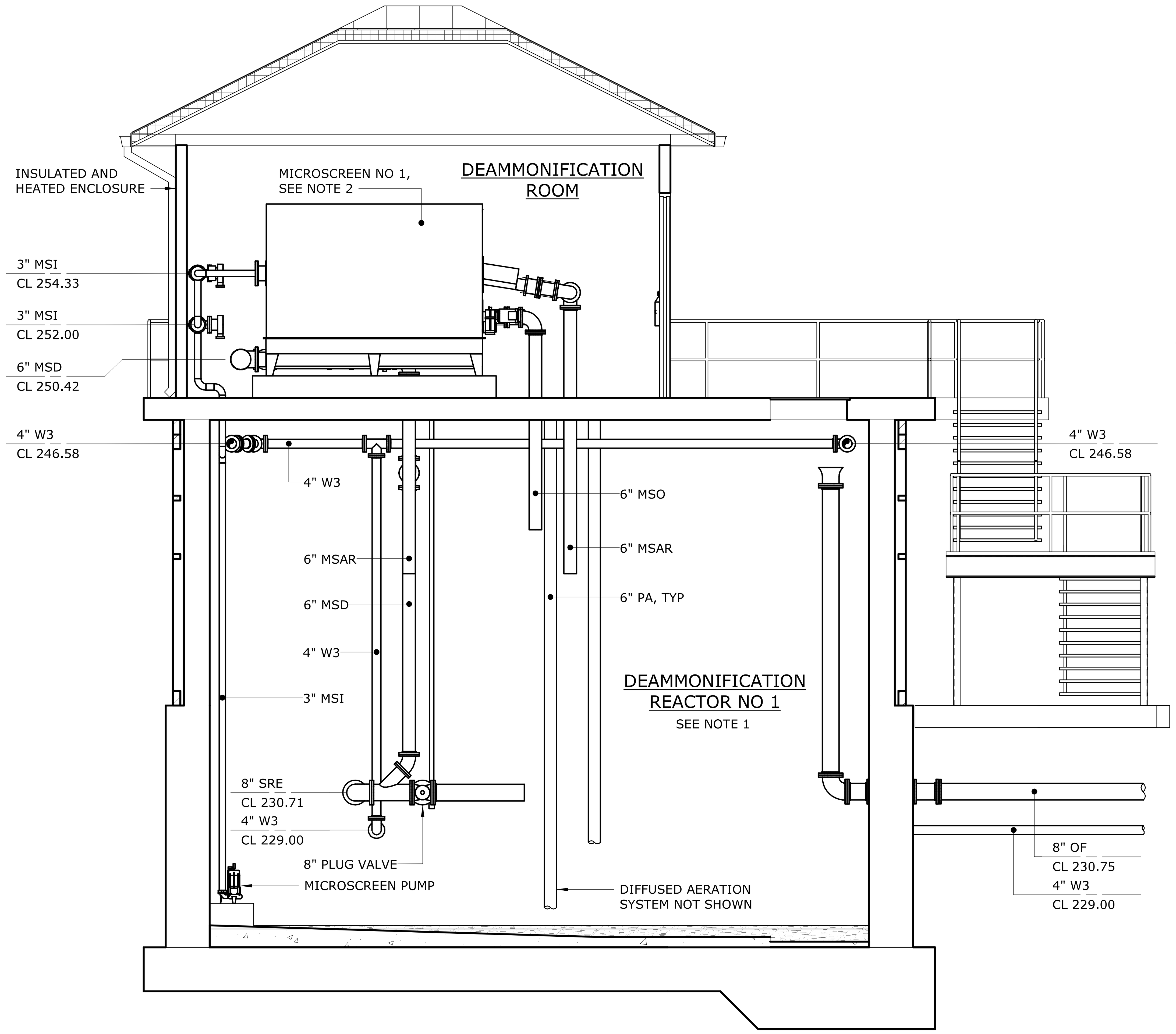
CONTRACT NO.: BRW.00002

DRAWING NUMBER: M7505

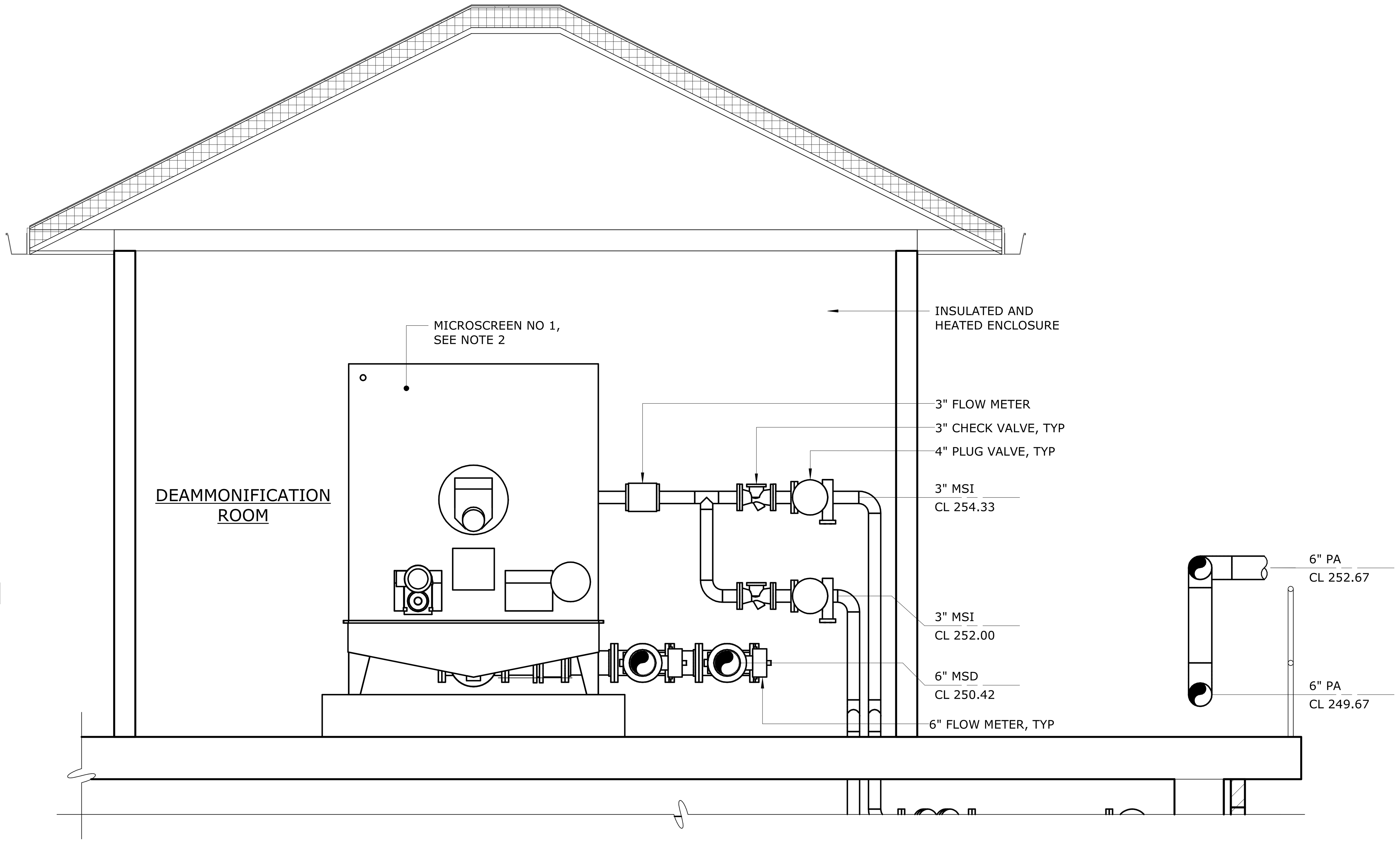
C:\Users\cbastin\Documents\33000-006-75-SST-MECH_cbastinPAEDG.rvt
10/12/2018 8:40:55 AM

NOTES:

1. REACTOR INTERNALS TO BE PROVIDED BY OFFEROR.
2. MICROSCREEN EQUIPMENT, ASSOCIATED PIPING, FITTINGS AND VALVES TO BE PROVIDED BY OFFEROR, IF APPLICABLE.



SECTION C
1/4" = 1'-0" M7502



SECTION D
1/2" = 1'-0" M7503

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10/12/2018 8:40:56 AM

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER:	P. YI
DESIGNED BY:	P. BASSETTE
DRAWN BY:	C. BASTIN
CHECKED BY:	J. CARROLL
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE	0 1/2" 1"

PRELIMINARY DRAWING
DO NOT USE FOR CONSTRUCTION

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD,
FAIRFAX, VA. 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

SIDESTREAM DEAMMONIFICATION
FACILITY (75)
PROCESS MECHANICAL
SECTIONS

DATE:	OCTOBER 2018
HAZEN NO.:	33000-006
CONTRACT NO.:	BRW.00002
DRAWING NUMBER:	M7506

NOTES:

1. OFFEROR SHALL PROVIDE AUTOMATIC CONTROLS FOR REACTOR INFLUENT PUMPS.

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER: P. YI

DESIGNED BY: K. LANDRY

DRAWN BY: J. VARELAS

CHECKED BY: D. EDWARDS

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE 0 1/2" 1"

PRELIMINARY DRAWING DO NOT USE FOR CONSTRUCTION

PNID SEAL

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD, SUITE 400
FAIRFAX, VIRGINIA 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

INSTRUMENTATION

SIDESTREAM DEAMMONIFICATION FACILITY EQUALIZATION

DATE: OCTOBER 2018

HAZEN NO.: 33000-006

CONTRACT NO.: BRW.00002

DRAWING NUMBER: I7501

NOTES:

1. ALL * ITEMS TO BE PROVIDED BY SIDESTREAM DEAMMONIFICATION SYSTEM MANUFACTURER.
2. OFFERORS SHALL SUPPLY SEPARATE PID FOR BLOWER CONTROLS.

REV	ISSUED FOR	DATE	BY	

PROJECT ENGINEER:	P. YI
DESIGNED BY:	K. LANDRY
DRAWN BY:	J. VARELAS
CHECKED BY:	D. EDWARDS

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE — 0 1/2" 1"

PRELIMINARY DRAWING DO NOT USE FOR CONSTRUCTION

PNID SEAL

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD, SUITE 400
FAIRFAX, VIRGINIA 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

INSTRUMENTATION

DEAMMONIFICATION REACTOR - DEMON

DATE:	OCTOBER 2018
HAZEN NO.:	33000-006
CONTRACT NO.:	BRW.00002
DRAWING NUMBER:	I7502

NOTES:

1. ALL * ITEMS TO BE PROVIDED BY SIDESTREAM DEAMMONIFICATION SYSTEM MANUFACTURER.
2. OFFERORS SHALL SUPPLY SEPARATE PID FOR BLOWER CONTROLS.

HMI

PLC

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER: P. YI
DESIGNED BY: K. LANDRY
DRAWN BY: J. VARELAS
CHECKED BY: D. EDWARDS

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE
0 1/2" 1"

PRELIMINARY DRAWING DO NOT USE FOR CONSTRUCTION

PNID SEAL

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD, SUITE 400
FAIRFAX, VIRGINIA 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

INSTRUMENTATION

DEAMMONIFICATION REACTOR - ANITAMOX

DATE: OCTOBER 2018
HAZEN NO.: 33000-006
CONTRACT NO.: BRW.00002
DRAWING NUMBER: I7503

NOTES:

1. ALL * ITEMS TO BE PROVIDED BY SIDESTREAM DEAMMONIFICATION SYSTEM MANUFACTURER.
2. OFFERORS SHALL SUPPLY SEPARATE PID FOR BLOWER CONTROLS.

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER: P. YI
DESIGNED BY: K. LANDRY
DRAWN BY: J. VARELAS
CHECKED BY: D. EDWARDS
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE 0 1/2" 1"

PRELIMINARY DRAWING
DO NOT USE FOR CONSTRUCTION

PNID SEAL

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD, SUITE 400
FAIRFAX, VIRGINIA 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

INSTRUMENTATION

DEAMMONIFICATION REACTOR - ANAMMOPAQ

DATE: OCTOBER 2018
HAZEN NO.: 33000-006
CONTRACT NO.: BRW.00002
DRAWING NUMBER: I7504

REV	ISSUED FOR	DATE	BY

PROJECT ENGINEER: P. YI

DESIGNED BY: K. LANDRY

DRAWN BY: J. VARELAS

CHECKED BY: D. EDWARDS

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO FULL SCALE 0 1/2" 1"

PRELIMINARY DRAWING
DO NOT USE FOR
CONSTRUCTION

PNID SEAL

Hazen

HAZEN AND SAWYER
4035 RIDGE TOP ROAD, SUITE 400
FAIRFAX, VIRGINIA 22030

LOUDOUN WATER

BROAD RUN WATER RECLAMATION FACILITY
16.5 MGD DESIGN FLOW
EXPANSION PROJECT

INSTRUMENTATION

CHEMICAL SYSTEMS

DATE: OCTOBER 2018

HAZEN NO.: 33000-006

CONTRACT NO.: BRW.00002

DRAWING NUMBER: I7505